JULY 1959

Power Engineering

ATOMICS . . . Special Bi-Monthly News Report from the Field 43
Electric Transmission Lines: How to Design and Build Them – I 58
Atlantic City Electric Designs for Steam System Flexibility 61
Recording Turbine Vibration Eases Analysis, Balancing 63
Streamlining Boiler Water Tests for Smaller Plants 67
Package Parts Simplify Boiler Port Gage Maintenance 68
New Protective Static Relays Show Many Advantages 70
Richmond Uses Sewage Plant Effluent as Make-Up Water 71
Industrial Power Plant Accounting – IV: Accurate Budgets 76
First U. S. Planetary Gear Installation Cuts Space and Costs 79
How to Accurately Measure with Portable, Versatile Dynamometers 80
New Recovery Process Furnishes Steam, Ends Stream Pollution 82
Tools and Maintenance Shops for the Power Engineer – II 84
It Takes a Lot of Pipe to Build a Large Power Plant 86
New Zealand Harnesses Subterranean Steam for 250,000 Kw 89
How to Maintain Centrifugal Pumps – 9: Complete Pump Check 92
Method of Estimating the Evaporation of Water from Open Tanks 94
Inexpensive Way to Put Water Treatment into Chilled Water Circuit 98

REGULAR DEPARTMENTS

Engineers' Preview 3
What They Tell Us 6
Helpful Bulletins 27
TRACERS 57
News Reel 74
Construction News 52
POWER ENGINEERING Handbook 92
Equipment News 100
Reader Service Post Cards 113
Catalog Library 113
Advertisers' Index 120
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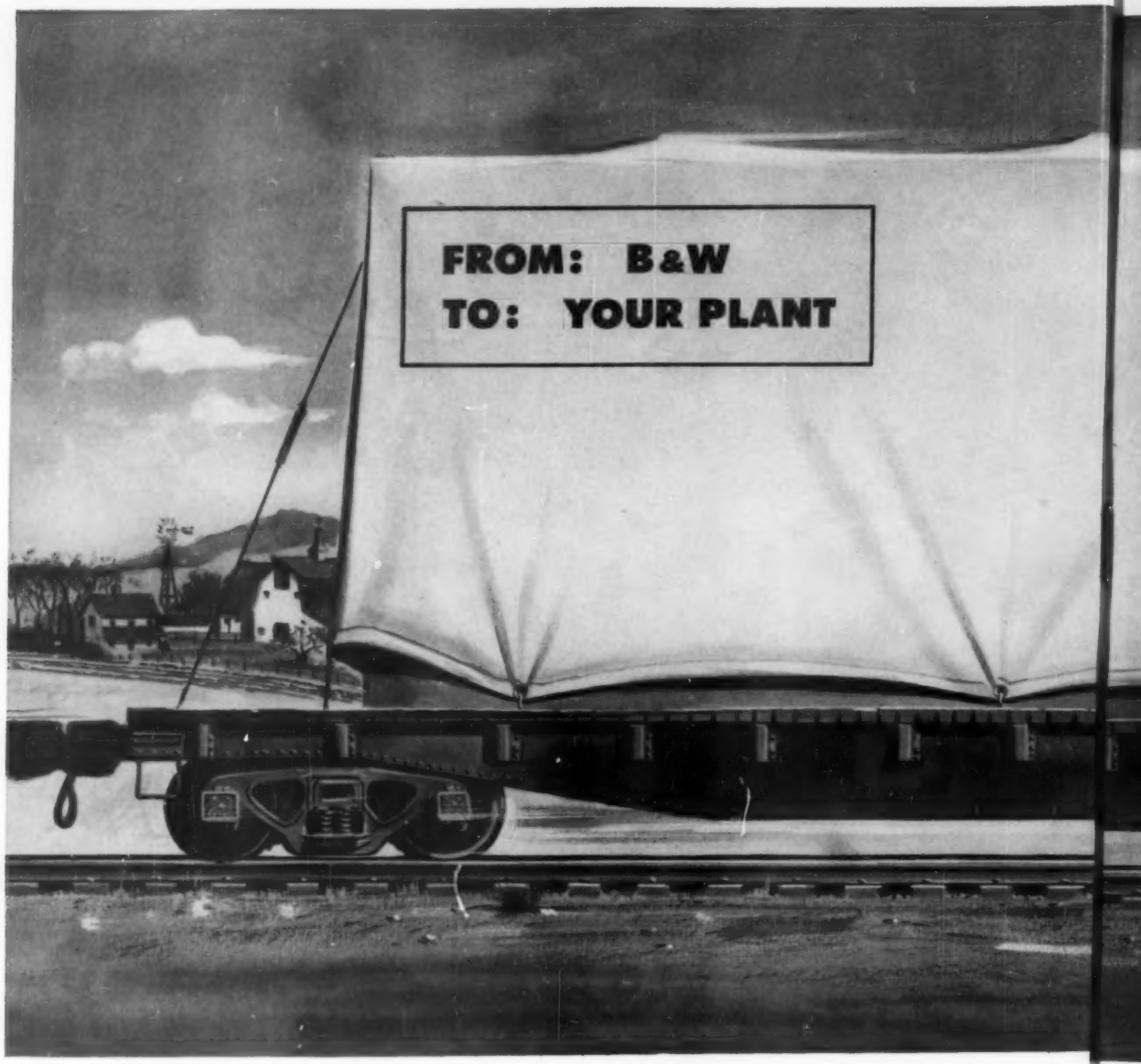

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Dependability—The entire furnace is water-cooled. That means less trouble; low maintenance. Also, the drainable superheater allows fast start-up and safe, rapid storage.

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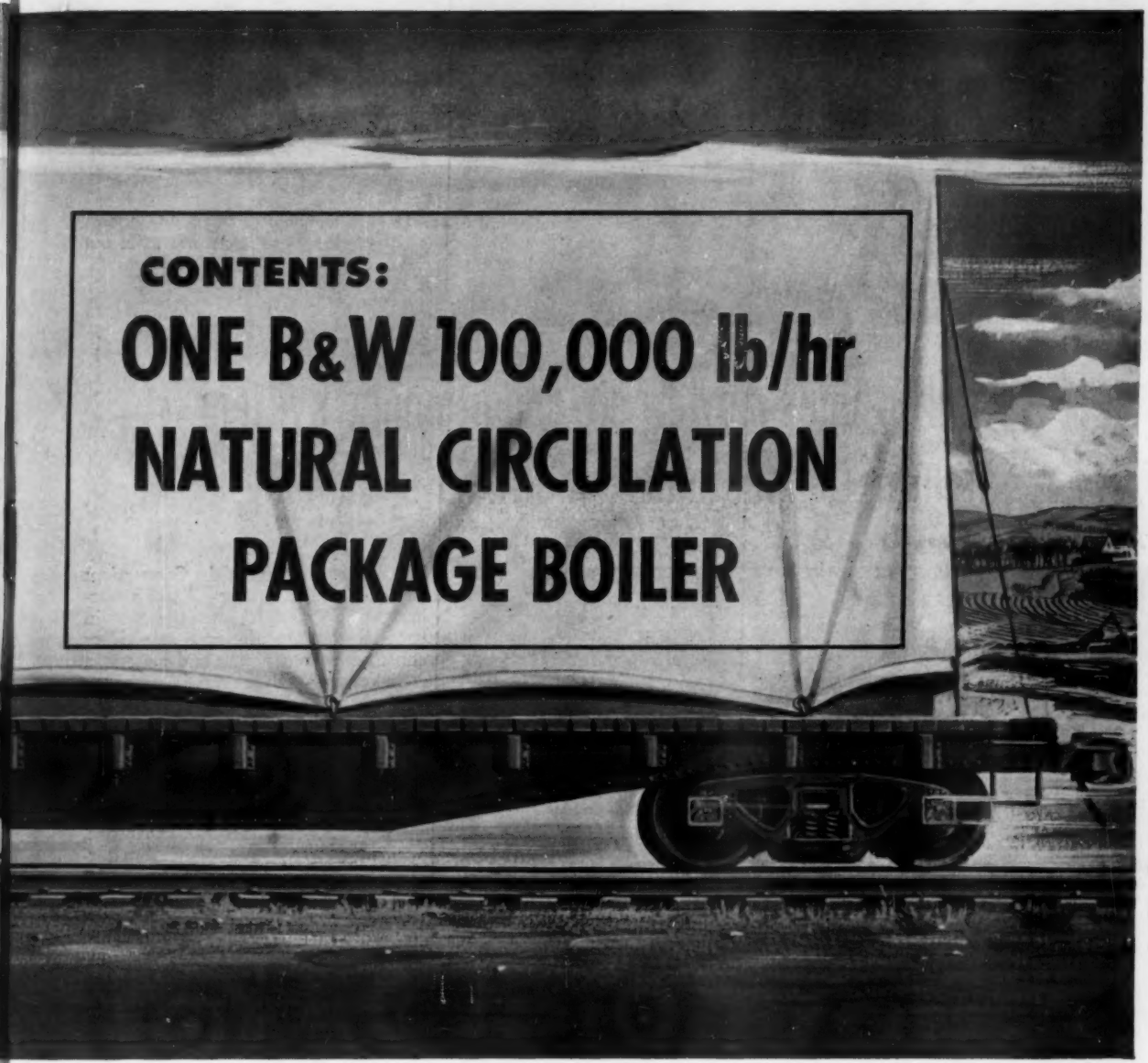

over, maximum circulation. Thousands of boiler installations have proved the superiority of Cyclone Separators.

Easy Installation—Remove it from the flatcar, make a few connections, start it up.

Three words sum up the advantages of the new B&W Type FO Package Boiler—*economy, convenience, quality.*

Get the complete details on the natural circulation, oil and gas fired B&W Type FO Package Boiler, from your local B&W Sales Engineer. Or write The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

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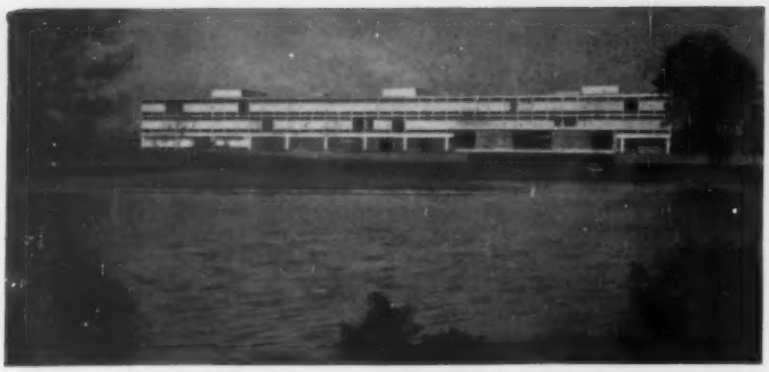
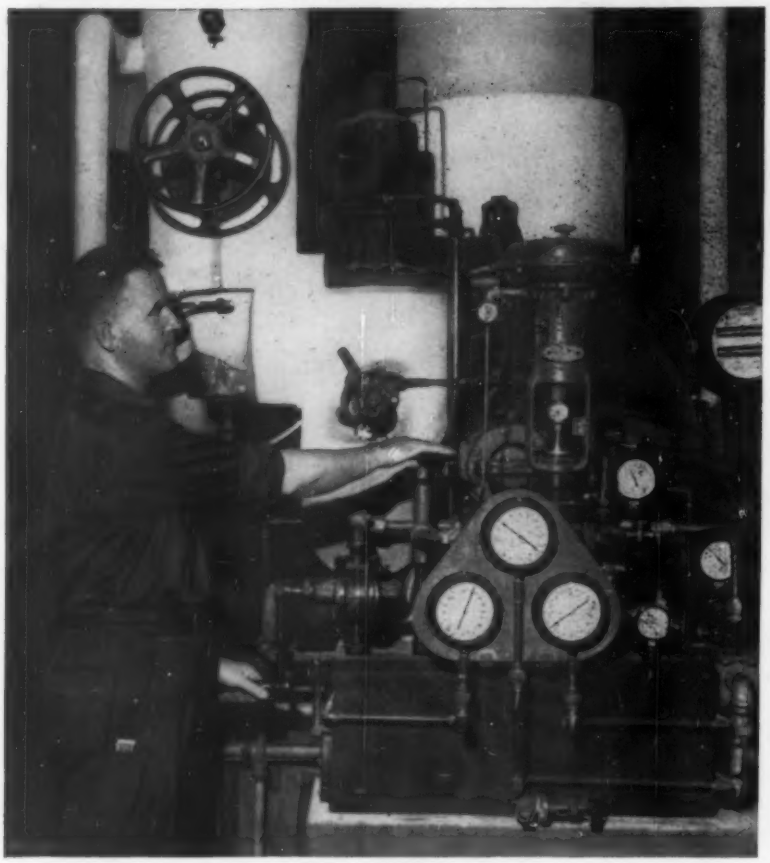


New home office for Connecticut General Life is a modern structure five miles out in the country.

Terry turbines power air-conditioning system at new Connecticut General Life building



One of two 870-hp, 3970-rpm Terry turbines built to drive the refrigeration compressors.

The new home office of the Connecticut General Life Insurance Co., in suburban Hartford, represents the best in contemporary architecture as well as construction techniques and materials.

In keeping with the careful planning evident throughout the project, two Terry turbines were selected to drive the York centrifugal refrigeration compressors. Terry turbines such as these have a record of low maintenance and consistent reliability under varied conditions. The steam generators, which are used for general heating during the winter months, furnish the power to operate the turbines. This provides an economical and dependable air-conditioning setup.

The steel and glass building accommodating 2500 employees overlooks New England farmland. It is furnished with modern equipment, to step up the efficiency of clerical work. Other amenities: lounges, game rooms, cafeteria, bowling alleys, barber and beauty shops, variety store, medical department.

If you are planning an air-conditioning system, perhaps you, too, should consider steam-turbine drive. Write for detailed information about the advantages of turbines for your specific requirements.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

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ENGINEERS' PREVIEW

SAHARA DESERT of North Africa is being viewed as the next big new source of oil for world markets, the New York *Times* reports. Most important recent oil discovery in Algeria has been near the Hassi R'Mel gas field, one of the world's largest.

But imports of natural gas rather than new oil imported will eventually be a larger problem for the U. S., according to William R. Connole, vice-chairman of the Federal Power Commission. As detailed in an article in POWER ENGINEERING in June, 1954, page 92, natural gas can be liquefied and transported in insulated tanks at a cost much less than that for pipeline and pumping stations.

Connole mentions liquefied methane especially in his evaluation of the gas imports situation. He says that the possibility of liquefying natural gas creates "a new branch of the petroleum industry," and brings with it international natural-gas competition. He suggests that the U. S. may have to set up a body similar to the Cabinet Committee on oil imports to consider gas competition.

TAXES or payments in lieu of taxes of about $14,800,000 will have been paid to states, counties, and municipalities by TVA and distributors of TVA power during the fiscal year which ended June 30. This is an increase of $1,000,000 over such payments in the previous fiscal year.

Payments this year by TVA to seven states and 137 counties will be $5,900,391, and payments to states and local governments by the municipal and coöperative distributors (excluding the City of Memphis, whose long-term contract with TVA expired a year ago) are estimated at $8,900,000.

The TVA payments are $4,581,504 more than the minimum payments required by the property tax replacement provision of the TVA Act. They are $628,484 more than they were for the 1958 fiscal year and $1,155,990 more than for the 1957 fiscal year.

State governments will receive $4,795,052 of the 1959 TVA payments of $5,900,391; county governments will receive $1,105,339. Rising TVA revenues from non-Federal customers account for the over-all larger payment this year.

PERSONALS: Robert M. Hatfield, formerly vice-president in charge of manufacturing of Combustion Engineering, Inc, has been appointed vice-president and general sales manager in charge of domestic sales. He will report to Donald S. Walker, vice-president and director of sales. Hatfield is an engineering graduate of Purdue University and joined Combustion in 1934.

Walker L. Cisler, president of Detroit Edison, is the official nominee for the 1959–60 presidency of ASME.

Dr. Benjamin R. Teare, Jr, Dean of the College of Engineering and Science at the Carnegie Institute of Technology, is the new president of the American Society for Engineering Education.

Walter J. Kinderman, director of engineering research at the Yarnall-Waring Co, has been named Metals Man of the Year by the Philadelphia Chapter of the American Society for Metals.

Newly-elected president of The Society of American Military Engineers is Vice Adm. W. Orme Hiltabidle, CEC, U. S. Navy, retired.

Frank A. Marston, partner in the Boston engineering firm of Metcalf and Eddy, is the official nominee for the 1959–60 presidency of ASCE.

Harold A. Mosher, associate director of engineering at Kodak Park Works of Eastman Kodak Co, has been elected president of the National Society of Professional Engineers.

J. H. Foote of Jackson, Mich, has been elected president of AIEE for 1959-60. Foote is chief engineer of Commonwealth Associates.

AIEE has announced the elevation of nine of its members to the grade

of Fellow — the Institute's highest grade. These men are: Myron A. Bostwick, protection engineer, Portland (Ore) General Electric Co; Willis H. Gille, chief engineer, Minneapolis-Honeywell Regulator Co; Shirley L. Goldsborough, retired, Vista, Calif; Joseph V. Lamson, area engineer, Seattle area, Bonneville Power Administration; Clifford B. McManus, chairman of the board and director of the Southern Co and vice-president and director of the Georgia Power Co; Edwin J. Merrell, chief engineer, Phelps Dodge Copper Products Corp; Theodore W. Schroeder, chief electrical engineer, Illinois Power Co; Philip C. Smith, assistant general manager, East Pittsburgh Div, Westinghouse Electric Corp; Laurence Wylie, consulting electrical engineer, Seattle.

HUGE SINTERING PLANT has gone into operation at Gary Steel Works of U. S. Steel Corp. It is capable of supplying 15,000 tons of iron ore sinter daily to the 12 blast furnaces at Gary Works.

Without the sintering process, the fine iron ore would be blown out of the blast furnace stacks as flue dust. Sintering process provides a uniform-sized product which allows an increase in blast furnace efficiency and iron-making capacity. The new sintering plant was designed and built by Dravo Corp, with machines licensed by the Lurgi Company of Frankfurt, Germany.

The sintering lines consist of three continuous traveling grates, 200 ft in length and more than 8 ft wide. Raw ore and coke are placed on these continuously moving grates.

Special gas-fired furnace is used to ignite the fuel contained in the mixture of iron ore and coke.

Each machine is served by a 3000-hp induced draft fan which pulls approximately 360,000 cfm down through 24 wind boxes. These fans draw the air through the material like a vacuum sweeper, fusing the ignited sinter mix on the grates.

Air and waste gases are then swept into a 12-ft-diam main, cleaned, and released through chimney stacks.

The sinter is discharged into 90-ft-diam coolers, where it is reduced from a temperature of 1000 F to below 250 F.

$740,000 prime instrumentation contract for the nuclear portion of the new Enrico Fermi Atomic Power Plant in Michigan has been awarded to Bailey Meter Co. Both pneumatic and electronic control systems will be used, each where most suitable. Bailey will use transistorized components in all electronic control systems.

CONTRACT in excess of $1,500,000 for three large steam generators for the Medina Electric Coöperative, Inc, Hondo, Texas, has been awarded to Cleaver-Brooks Co by the Rural Electrification Administration.

Cleaver-Brooks will manufacture and field-erect three water-tube steam generators, each with a capacity of 235,000 lb per hr of steam, or a total capacity of 705,000 lb per hr. They will be manufactured by the Springfield Boiler Co, a subsidiary of Cleaver Brooks.

The three steam generators are based on a special modern design in which pressurized firing is employed. The new generating plant north of Pearsall, Texas, when completed will have electric generating capacity of about 75,000 kw. Field-erection of the steam generators is scheduled for completion by December, 1960. They will be installed out-of-doors with special all-weather protective exteriors.

EJC, representing more than a third of the nation's engineers, is solidly backing the creation of a Cabinet-level Department of Science and Engineering.

President Enoch R. Needles advocates a Department of Science and Engineering which would have not only responsibility, but the authority to act as well. He has pointed out to a Senate subcommittee that activities in science and engineering have progressed and are progressing so rapidly that new demands are constantly being made of government, industry, and higher education; and the activities of engineering have widened to a point where responsible leadership in government is needed to bring about an efficient and fully developed long-range program for science and engineering.

"Under the current diversity of organizational effort there is real danger that important areas of new knowledge will not receive the attention and research support they merit," Mr. Needles concludes. "We are speaking, of course, of those areas in which integrated planning by the government is required because of the enormous scope of the problems and because it represents the welding of many joint intellectual efforts."

The EJC statement concluded that the new department should bring together the activities of a broad engineering and scientific nature not directly pertinent to the missions of other departments and should, in addition, coördinate science and engineering in such departments by some device such as the Federal Council for Science and Technology.

EDISON AWARD, newly established by the Edison Electric Institute, has been given to the Alabama Power Co, for "exceptional business statesmanship" in developing the water resources of the Coosa and Warrior River systems. The Edison Award replaces the Charles A. Coffin Award, which has been given at EEI conventions from 1922–1957. This is the first year for the Edison Award.

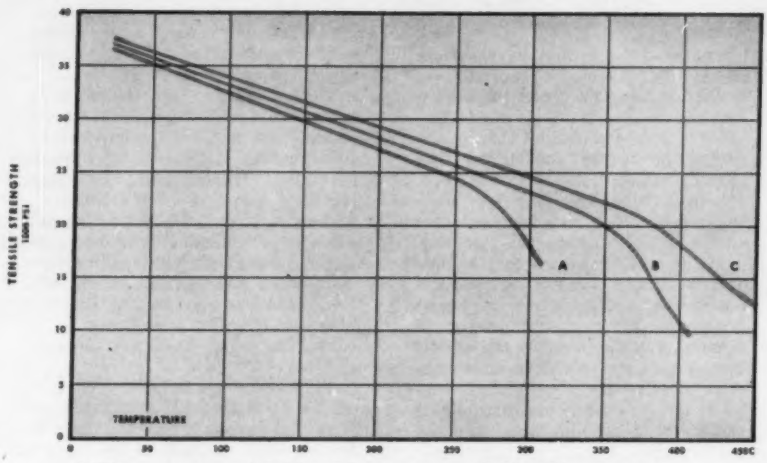
CUTLER-HAMMER's valve operator division has been purchased by the Hupp Corp. Manufacturing operations will be moved from Milwaukee to the Chicago plant of the Hupp Aviation Co division, and Hupp Aviation will be responsible for service of Cutler-Hammer valve operators now in service. The Hupp-made product will be known as Electrodyne valve actuators. New designs will be developed for petroleum, utility and waterworks applications.

WESTINGHOUSE has created a new power control and communications department. V. B. Baker, formerly administrative assistant for the switchgear apparatus departments, will be manager of the new department. Purpose is to consolidate a number of related activities now carried on at the company's East Pittsburgh and Halethorpe operations. The company will now have at one location the various elements which form complete control and communications systems.

ANACONDA® COPPER PRODUCTS

FOR THE ELECTRICAL INDUSTRY

THE AMERICAN BRASS COMPANY • WATERBURY 20, CONN



A. Silver content normal. **B.** Silver 8.7 ounces per ton. **C.** Silver 28 ounces per ton.

Silver-bearing coppers give a margin of safety in operating conductors at elevated temperatures

In heavily loaded motors and generators, the windings, collector rings, and commutators must retain their strength at the higher operating temperatures that have become the rule. And there are now many other places where copper conductors must operate at temperatures well above those heretofore considered normal.

Electrolytic copper—with a very small amount of silver added—is superior to any other commercial conductor metal for use at these higher temperatures. Anaconda silver-bearing copper retains the structural design strength of the conductor at the higher operating temperatures. Annealing temperature is raised and softening delayed. The margin of safety is improved. How much gain you can count on is indicated by the chart above.

The curves are the result of tests made by the Metallurgical Research Laboratory of The American Brass Company.

There are three standard Anaconda alloys: Silver Bearing Copper-111, silver 8 troy ounces per ton, average conductivity, annealed, 101%; Silver Bearing Copper-112, silver 10-15 troy ounces per ton, average conductivity, annealed, 100.5%; Silver Bearing Copper-113, silver 25-30 troy ounces per ton, average conductivity, annealed, 100%.

More detailed information concerning the influence of silver on the tensile properties of high-conductivity copper at elevated temperatures is given in Publication C-25, "Anaconda Copper for Electrical Conductors." Included are curves for yield strength at 0.2% offset and 0.5% extension—indices of the limits of elastic behavior—of interest to design engineers.

DO YOU KNOW THESE ELECTRICAL COPPERS?

DLP COPPER-104 (Cu 99.9+, P 0.01) average conductivity, annealed, 97%. High-conductivity type of phosphorus deoxidized copper excellent for brazing, soldering—is being used increasingly by electronics manufacturers—also in such places as transformer bushings.

CHROMIUM COPPER-999 (Cu 99.05, Cr 0.85, Si 0.10) average conductivity, annealed, before heat treatment, 40%; after precipitation hardening, 80%. This unique alloy when precipitation-hardened has very good mechanical properties well above 200 C. This leads to its use, for example, as tips and wheels in resistance welding equipment. Is also regularly used for switch contacts and similar applications at around room temperature.

BELOW: Railway motor commutator segments, having precise taper and contour, made of Anaconda Silver Bearing Copper-113.

Electrical conduit and raceways of tough, nonmagnetic Everdur guard circuits from corrosion, vibration

Where power, control, or signal circuits must be buried, hidden, or protected from severe corrosive conditions and vibration, electrical conduit or seamless raceways of Everdur® give enduring protection. Everdur, Anaconda copper-silicon alloy, offers not only unusual resistance to corrosion, but also high strength and resilience to withstand movement, vibration, abrasion, and rough use. In addition it is nonmagnetic, providing electrical advantages. For complete information write for Publication E-12. 5971

RIGHT: 90-degree bends made in 3", 3½", and 4" Everdur raceways.

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WHAT THEY TELL US

▶ **READER NICHOLAS S. HODSKA,** who is also a POWER ENGINEERING author, writes of the May issue:

> Many thanks for the May, 1959 copy of POWER ENGINEERING you sent me, plus the reprint of my article, Nomogram for Determining Draft Differential. It really looks dandy and I appreciate the publication of my article in your fine magazine. Yours is a power-packed magazine. Good ideas, good presentations. I have just read the last issue from cover to cover, and found it highly absorbing. I particularly like your editorial articles. They are excellently prepared, sound, and very interesting. Keep up the good work.

▶ **MARTIN FRIEDMANN, JR** is a versatile welding contractor. One of his specialties is the welding of hydroelectric turbine runners, and sometimes pump runners, to fill up the pitted places caused by cavitation and restore the runner blades to their original shape. As all engineers know, this cavitation, if allowed to continue until it gets serious enough, will greatly affect the efficiency of the hydraulic turbine or pump; and some engineers have even thought that it may cause the unit to vibrate.

At any rate, the outstanding thing about Mr. Friedmann's work is that he builds up the cavitation areas in these hydraulic turbines *without taking the turbine runner out of its setting.* Many people say this cannot be done, but Mr. Friedmann and his crew actually do it, and in the near future he is going to describe some of his methods and show some of the results of this operation.

In all this work, he has been studying cavitation itself, and says he has a new theory of cavitation of hydraulic turbine runners. He explains:

> The accepted theory of cavitation is related to small vacuum bubbles found when water passes an uneven surface at great velocity; the collapse of these bubbles causes cavitation by tearing out small particles of metal. This theory is sound up to a point.
>
> Close examination of typical cavitation, however, shows a remarkable similarity of structure breakdown to that of electrodes in a plating bath. This gives rise to a number of theories.
>
> To go back to the basic principles: where energy is in motion, electrical charge is generated. Similarity of cavitation to electrolysis on a ship hull should not be overlooked. The velocity of the water, of course, prevents the oxide formation that spreads the ship electrolysis pattern. In draft tube and impeller blade cavitation, this velocity removes oxides as soon as formed.
>
> As a welding contractor, I have done a number of cavitation jobs and notice a definite pattern in draft tube liner cavitation in a north and south direction. On the runners, the cavitation seems to be at the electrical center of the blades. The electrical center is not necessarily the mechanical center. Mass and motion vary the pattern also.
>
> If some government agency or large turbine manufacturer would like to make a study of these theories, I would be glad to show them my material. Also, I would appreciate any pattern data on cavitation, location, size, depth and relation of draft tube cavitation to compass points.

The editors know one other man who is studying electrical theories of cavitation, and we have put him in touch with Mr. Friedmann. Something interesting and valuable, not only for hydraulic turbines but for pumps as well, may come out of this.

▶ **IN APRIL,** J. W. Hollis, Jr outlined in this column his idea for a catalog service to engineering offices. Commenting on the idea, A. F. Bochenek, development engineer with the Bituminous Coal Institute,writes:

> This problem of how manufacturers of engineering equipment can best serve the engineering profession is a matter that has received considerable attention from consulting engineers. The problem in the engineering offices transcends that of merely maintaining an up-to-date catalog file.
>
> A survey of consulting engineers published in the October, 1957 issue of *Consulting Engineer,* points up the need for a general improvement in the sales literature intended for engineers. A good piece of descriptive sales literature should be heavily weighted with useful technical data. It should include dimensions and prices and give a reasonable indication of installation and operating costs. It should warn against misapplications. Manufacturers should agree upon a usable catalog filing system. In general, consulting engineers appealed for more factual in formation.
>
> The coal industry through the Bituminous Coal Institute is already providing the type of service to consulting engineers which Mr. Hollis proposes. BCI has inaugurated a series of Fuel Engineering Data Bulletins which eventually will review the entire spectrum of coal-burning technology in a form directly useful to consulting engineers.
>
> These bulletins are issued to a selected list of consulting engineers and as far as possible are delivered by BCI district engineers, who insert them in a special folder. BCI also conducts a review of the literature and reprints useful articles illustrating good engineering practice in design of coal-fired plants. These are distributed and inserted in the BCI folders. In this way the coal industry hopes to keep at the fingertips of consulting engineers current information on how to use its product.
>
> We wish to compliment Mr. Hollis on his enterprise and originality and wish him success in his venture. We feel his effort will help to direct attention of manufacturers of engineering equipment to the special needs of consulting engineers.

▶ **NEW PICTURE** of the electricity supply industry in Britain reaches us in a letter to Dick Morris, POWER ENGINEERING'S editorial director, from S. A. Clarke, Electrical Engineer for the Central Electricity Generating Board. Clarke writes:

> How nice of you to send me copies of photographs taken at the Cigre meeting in Paris. Your letter arrived at a moment when the whole of the electricity supply industry was being reorganized. I am now the Electrical Engineer of the Southern Project Group of the C.E.G.B. You might like to know roughly our new organization.
>
> Formerly there were ten Divisions and ten Area Boards of the Central Electricity Authority. The Divisions built and operated the power stations and the main transmission system, and sold electricity to the Area Boards who in turn sold it to the consumers. Following the Herbert Report and the 1957 Electricity Act it was decreed that generation construction which had been dealt with on an individual basis by each Division would be taken out of the Divisions.
>
> These construction departments were regrouped in three groups, Southern, Midland and Northern. The Southern Group for which I am working covers an area south of a line from the Severn to the Wash. Apart from the generation construction, the old Divisions continue, at present anyhow, to function as they did before, but they are grouped into regions consisting of several Divi sions for administrative purposes.

Some Straight Talk On Steam Trap Capacity

...or pulling away the curtain of confusion that surrounds steam trap capacity ratings.

Unfortunately, for the steam trap buyer, the subject of steam trap capacity has become cloudy and confused by a landslide of claims, counterclaims and inconsistent "standards" for measurement. So let's take a cold hard look at this subject so vital to the efficient operation of your plant.

What Determines Steam Trap Capacity?

There are three factors that determine the capacity of a steam trap:

1. The area of the orifice.
2. The density of the condensate.
3. The pressure differential across the trap.

Let's take a closer look at each of these:

Area of orifice is usually specified by the trap manufacturer or can be calculated from the diameter. Nothing complicated here.

Density of condensate depends on temperature. A cubic foot of cold water weighs 62.4 lbs. At 250° F. or 15 psi, it weighs less than 59 lbs. This is important. Don't overlook it.

Pressure differential across the trap is most significant. And it is complicated by the many factors that affect it, such as:

1. Pressure drop between unit drained and the trap when the trap valve is open.

2. Distance the trap valve is moved from the valve seat.

3. Back pressure on the trap with orifice closed; i.e., return header pressure.

4. Increase in back pressure produced by condensate and flash steam flowing in the discharge line. This in turn is affected by the diameter and length of the discharge line, plus friction caused by valves and fittings.

Orifice Capacity Vs. Steam Trap Capacity

Figure 1 shows a ½" diameter sharp-edged orifice at the end of a pipe filled with cold water at 15 lbs. pressure. The capacity of this orifice, using a .61 coefficient of flow would be 8,800 lbs. per hr. Now, would this ½" orifice if used in a ¾" steam trap installed as shown in Figure 2 provide the trap with a continuous discharge capacity of 8,800 lbs. of hot condensate per hour? The answer is "no". And here are some of the reasons why:

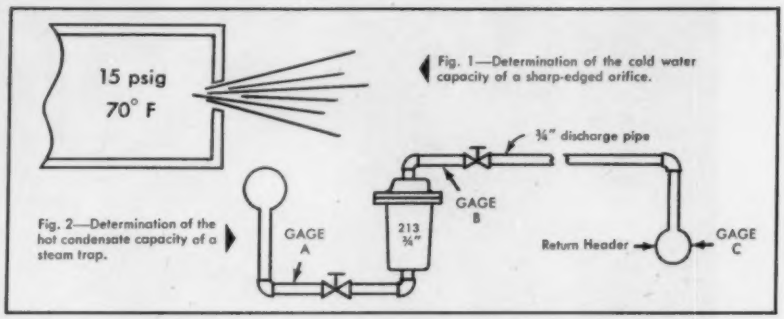


Fig. 1—Determination of the cold water capacity of a sharp-edged orifice.

Fig. 2—Determination of the hot condensate capacity of a steam trap.

Density of condensate. As pointed out above, cold water weighs 62.4 lbs. per cu. ft. At 15 lbs. pressure and 250° F. water weighs less than 59 lbs. per cu. ft. This difference in density alone reduces the lbs. per hour capacity of the orifice by over 5%.

Pressure differential across the trap. With the trap valve closed we have a static pressure differential of 15 psi. The trap valve must be able to open against this pressure. However, this is not the pressure differential that will determine the capacity of the trap valve.

The ¾" discharge line will be full of a mixture of flash steam and condensate. To keep this mixture flowing from the trap outlet to the return line requires a pressure differential. In actual capacity tests run as shown in Figure 2 Gage B at the trap outlet registered 11 lbs. back pressure. Thus the true pressure differential across the trap was about 4 lbs. Under these conditions the measured capacity of the trap was 4,340 lbs/hr. or just about half of the capacity of the ½" orifice for cold water.

How Armstrong Determines Capacity Ratings

Armstrong trap capacity ratings are based on hundreds of tests under actual operating conditions. In these tests, the condensate used was at the steam temperature corresponding to the test pressure. Thus, the capacities determined take into account the pressure drop that occurs when the trap orifice opens and the choking effect and back pressure of the flash steam. Actual installation hookups were used so that pipe friction in both inlet and discharge lines as well was reflected in the results.

Let's go back to the example cited above and in Figure 2. The trap referred to is an Armstrong No. 213. While it did test out at 4,340 lbs. per hour for a static pressure differential of 15 psi, it is rated in the catalog at only 3900 lbs. per hour for this pressure—just to be on the safe side.

For the trap buyer, this means that Armstrong Steam Trap capacities are based on handling condensate at steam temperature for the stated static steam pressure differential under actual working conditions.

Capacity ratings which don't take into account all of the variables will be misleading and may lead to the selection of undersized traps. So whenever you specify or buy traps be sure that the capacity ratings you work from are realistic. One way to be sure is to select Armstrong Traps with *guaranteed* capacity ratings.

* * *

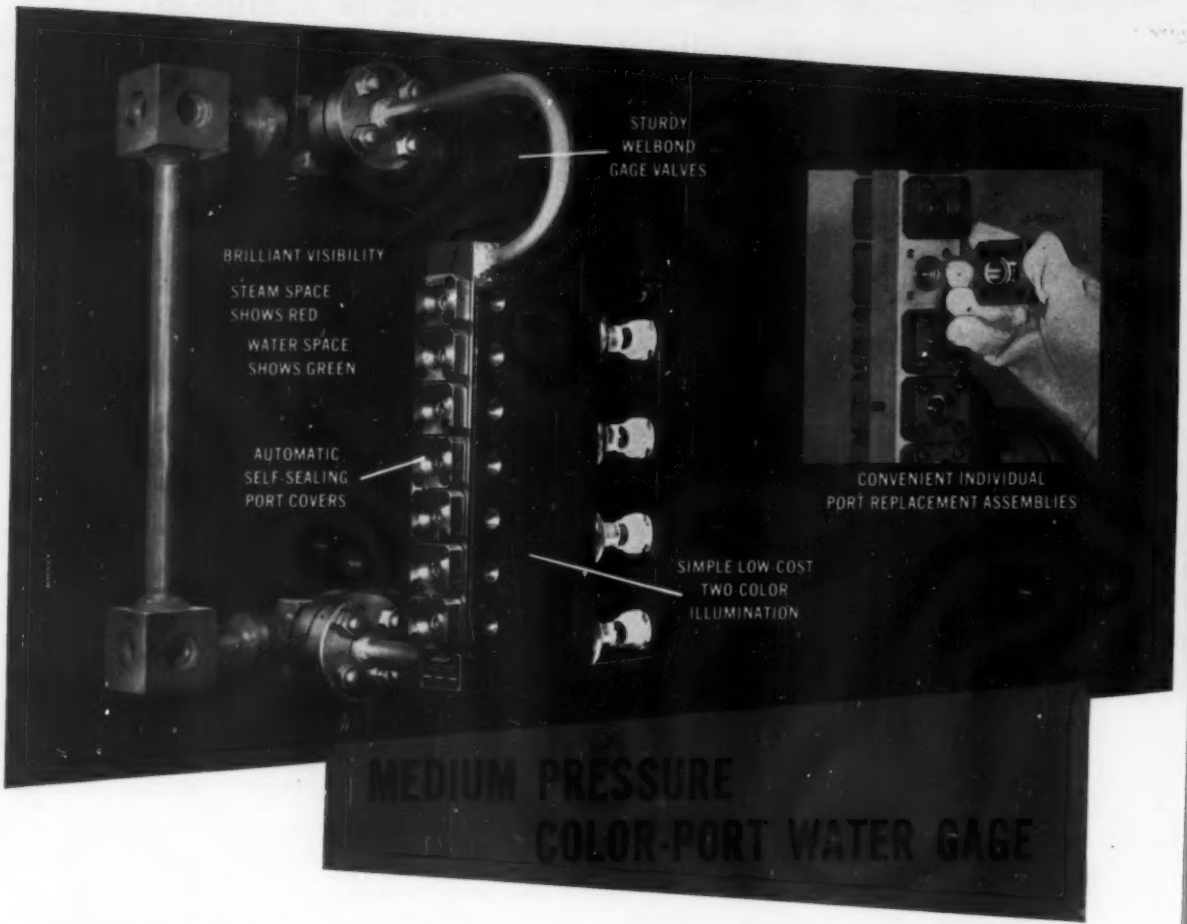
Additional information on trap capacity ratings, plus data on how to correctly size, install and maintain steam traps for any pressure, any temperature and any load, are presented in the 48-page Armstrong Steam Trap Book. Ask your local Armstrong Representative for a copy or write:

Armstrong Machine Works
8107 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

For more data circle 504 on Post Card

NEW YARWAY TRIM FOR MEDIUM FEATURES AND DEPENDABILITY


STURDY WELBOND GAGE VALVES
BRILLIANT VISIBILITY
STEAM SPACE SHOWS RED
WATER SPACE SHOWS GREEN
AUTOMATIC SELF-SEALING PORT COVERS
CONVENIENT INDIVIDUAL PORT REPLACEMENT ASSEMBLIES
SIMPLE LOW-COST TWO-COLOR ILLUMINATION
MEDIUM PRESSURE COLOR-PORT WATER GAGE

These advantages, so successful in high pressure* Yarway Color-Port Water Level Gages, are now incorporated in the new Yarway Color-Port for boilers operating up to 1050 psi.

- Bright red and green readings. Full gage shows all green; empty gage, all red.
- Low maintenance. Individual port assemblies can be replaced in a matter of minutes—with the gage in place. Efficient illuminator spotlights reduce lighting costs.
- Automatic self-sealing ports. Exclusive spring loading of port covers maintains proper pressure on glasses and gaskets at all times.
- Sturdy Yarway Welbond Gage Valves for positive, dependable shut-off service.

For replacement on existing medium pressure boilers or specifying on new units, make sure your next gages are YARWAY COLOR-PORT. Visibility ranges of 13″, 15½″ and 18″ available.

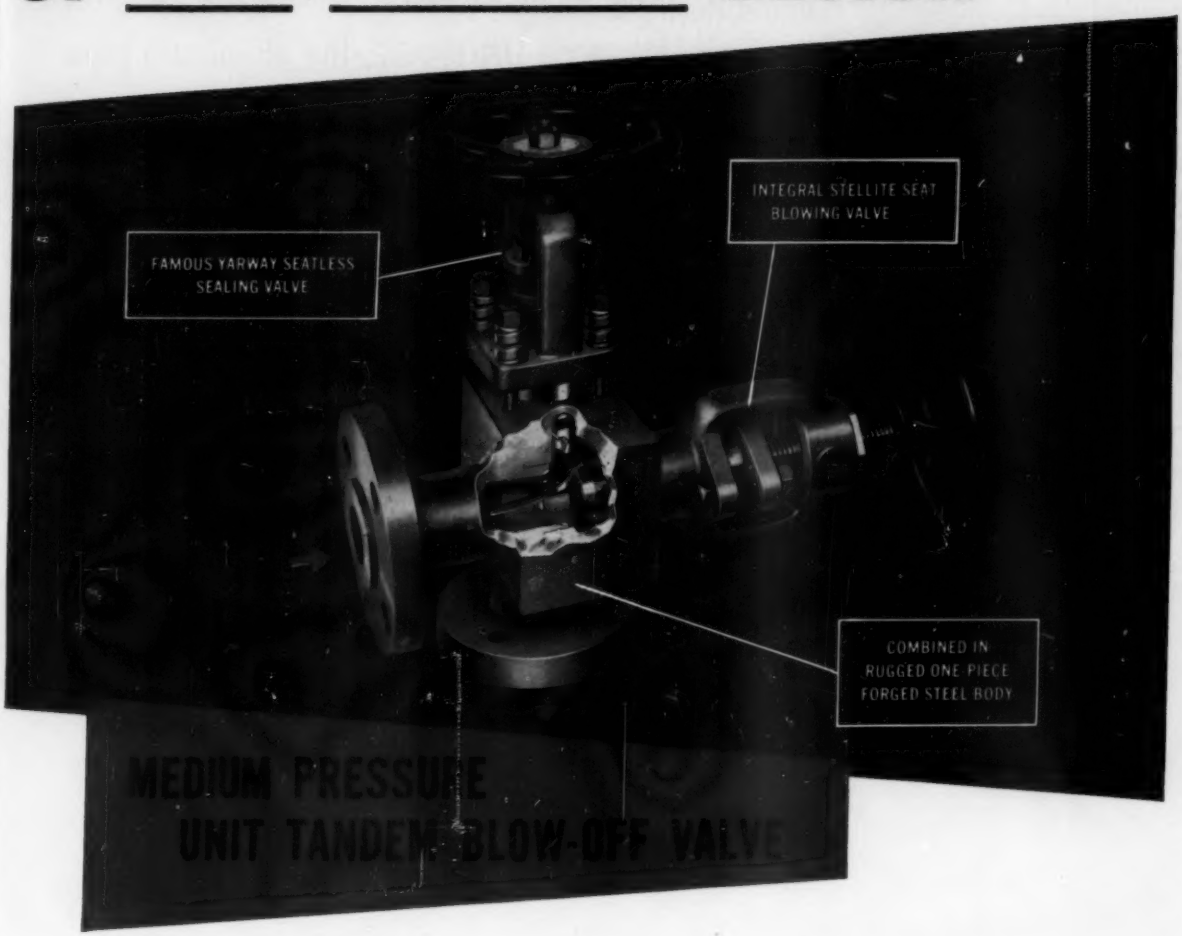
Write for new Bulletin WG-1815.

*up to 3000 psi

YARWAY

A MARK OF QUALITY

PRESSURE BOILERS HAS UNIQUE OF HIGH PRESSURE DESIGN


FAMOUS YARWAY SEATLESS SEALING VALVE
INTEGRAL STELLITE SEAT BLOWING VALVE
COMBINED IN RUGGED ONE PIECE FORGED STEEL BODY
MEDIUM PRESSURE
UNIT TANDEM BLOW-OFF VALVE

The established success of the high pressure Yarway Unit Tandem Valve is directly responsible for this new medium pressure Yarway Valve. It brings premium quality Yarway dependability to medium pressure boilers (up to 665 psi)—*at a competitive price.*

Important Yarway features like nitralloy plunger in the sealing valve, integral stellite seat and disc in the blowing valve, streamlined design, rugged forged steel body—make this your best blow-off valve buy.

Install this new Yarway Medium Pressure Unit Tandem and you'll know why *over 80% of all high pressure plants are Yarway Blow-off Valves.*

Write for Bulletin B-435, Supplement A.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

IN STEAM ENGINEERING

For more data circle 305 on Post Card

See why ALCOA ALUMINUM makes a good design habit

Requirement: Apply heat to piping when a product must be kept liquid during transfer

Key to Good Design: Use Alcoa UNITRACE, the aluminum pipe with integral steam tracing

The problem of applying heat to product piping can be solved efficiently and economically with ALCOA* Unitrace, the aluminum pipe with the integral steam passage.

In Unitrace, the steam and product passages are extruded as integral segments of a single piece of ALCOA 6063-T5 aluminum alloy. The outside diameter of the entire unit is round like conventional pipe, permitting fast, easy erection with standard type fittings.

With Unitrace, you get the advantages of low cost, easy bending and quick fabrication. Unitrace eliminates the labor and cost involved in installing external steam jackets or steam tracer tubes. Lightweight lengths of Unitrace can be joined by flanged connections, or by welding, as illustrated. Where valves and fittings are incorporated in the product line, the steam can be carried around the fittings by a jumper line.

ALCOA Unitrace has aluminum's natural corrosion resistance, making it well adapted for transferring molten sulfur, ammonium nitrate solutions, glacial acetic acid, fatty acids, naphthalene, phthalic anhydride, urea, wax, tar products, syrups, and numerous other products which must remain in liquid state during transfer.

*Registered Trademarks of Aluminum Company of America

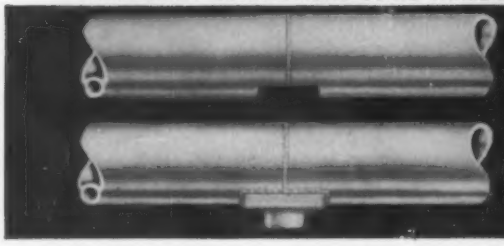
Unitrace is now available in standard pipe diameters from 1 in. through 8 in. Special cast Unitrace flanges, trace-caps, elbows and adapter flanges of ALCOA A356-T7 alloy make possible complete Unitrace piping systems.

ALCOA engineers have worked closely with all segments of the process industries for over 40 years and can help you specify the aluminum alloy tubular products and equipment best suited for your particular process applications. ALCOA's unparalleled experience in this field is available to you for the asking. Write to the address below, stating your requirements as specifically as possible. ALCOA's development engineers will welcome the opportunity to work with you on your problems.

You also can take advantage of the wide selection of free ALCOA literature on aluminum for Unitrace and other process applications. Simply check the booklets you want on the coupon and mail to the address indicated. ALCOA will forward you the material promptly and without obligation.

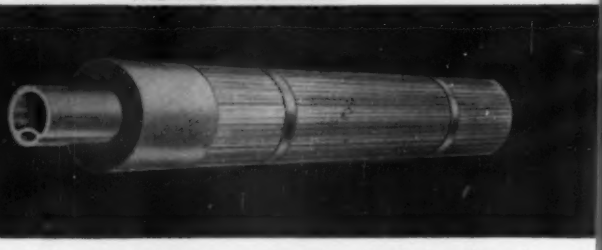
During 1959, ALCOA will conduct engineering conferences in a number of major cities on process industries applications of aluminum. Contact your nearest ALCOA sales office for full particulars and dates.

UNFLANGED CONNECTIONS USING TRACE-CAP



Where flanging is not required, sections of Unitrace can be joined easily and inexpensively by employing trace-cap. This is done by cutting back the trace line about an inch on the two sections of Unitrace to be joined. The product line then can be joined with a circumferential weld using 4043 weld wire. The trace-cap is then welded over the cut-away section to seal off the steam trace section of the Unitrace.

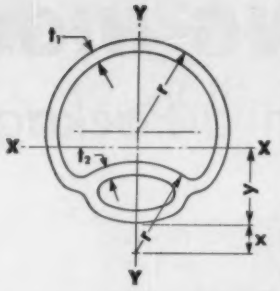
THERMAL INSULATION



Alcoa Unitrace is designed to accommodate standard preformed pipe insulation. Boro-silicate glass wools or foams, or calcium silicate types are preferred. No protection of the aluminum surface is needed with these insulations. If cork, hair felt, asbestos cement or mineral wool is used, the aluminum surface should be coated with Aluminum Metal-and-Masonry Paint.

Temp. °F	Pressure psi	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
Up to 100°F	Bursting Pressure of Product Line	2980	2265	1925	1425	1210	1210	1085
	*Pressure Differential	2240	1700	1445	1070	910	910	815
	Bursting Pressure of Trace Line	2980	2265	1925	1425	1210	1210	1085
200°F	Bursting Pressure of Product Line	2800	2130	1810	1340	1140	1140	1020
	*Pressure Differential	2100	1600	1360	1005	855	855	765
	Bursting Pressure of Trace Line	2800	2130	1810	1340	1140	1140	1020
300°F	Bursting Pressure of Product Line	2530	1920	1630	1210	1030	1030	925
	*Pressure Differential	1860	1410	1200	900	755	755	675
	Bursting Pressure of Trace Line	2530	1920	1630	1210	1030	1030	925
400°F	Bursting Pressure of Product Line	1340	1020	865	650	545	545	490
	*Pressure Differential	670	510	435	320	275	275	245
	Bursting Pressure of Trace Line	1340	1020	865	650	545	545	490

*The pressure in the product line should not exceed the pressure in the trace by more than this amount.
Note: Bursting pressure data based on tests with welded Unitrace flanges and minimum mechanical properties.



	Unitrace Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
Axis XX	Moment of Inertia (I) in.⁴	.09	.34	.72	2.71	6.52	31.82	81.82
	Radius of Gyration (R) in.	.37	.58	.72	1.09	1.42	2.12	2.78
	Section Modulus (S) in.³	.13	.34	.56	1.42	2.65	8.73	17.22
Axis YY	Moment of Inertia (I) in.⁴	.09	.33	.70	2.65	6.36	29.72	76.70
	Radius of Gyration (R) in.	.37	.57	.71	1.08	1.40	2.05	2.69
	Section Modulus (S) in.³	.14	.34	.59	1.52	2.83	8.97	17.79

Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
r	.657	.950	1.187	1.750	2.250	3.312	4.312
t_1	.133	.145	.154	.170	.187	.280	.322
t_2	.145	.163	.174	.185	.200	.307	.354
x	.133	.344	.406	.625	.813	1.500	2.000
y	.61	.87	1.08	1.59	2.03	2.98	3.87

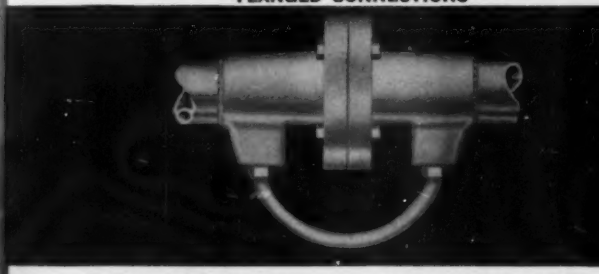
Unitrace Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
Product Area (in.²)	.64	1.68	2.72	6.38	10.84	24.64	42.79
Trace Area (in.²)	.10	.16	.35	.98	1.86	2.85	5.12
Metal Area (in.²)	.65	1.03	1.39	2.28	3.24	7.05	10.60
Weight (lb/ft)	.77	1.22	1.66	2.71	3.85	8.38	12.60
*Min. Bend Radii (in.)	5	8	10½	17	24	36	48
Wetted Perimeter							
Product	3.35	4.92	6.31	9.68	12.72	18.63	24.75
Trace	1.49	1.71	2.40	4.13	5.32	6.75	9.63
Fitting Weights (lb)							
Trace-Caps	.102	.126	.240	.464	.674	1.67	2.92
Elbows	.706	1.347	2.111	5.244	9.649	27.76	52.51
Impingement Plates	.024	.039	.057	.101	.162	.22	.34
Flanges	1.186	1.919	2.851	5.515	7.762	12.93	18.62

	1-2 in.	1½-2½ in.	2-3 in.	3-4 in.	4-6 in.	6-8 in.
Adapter Flanges	2.419	3.816	4.774	7.216	11.106	19.23

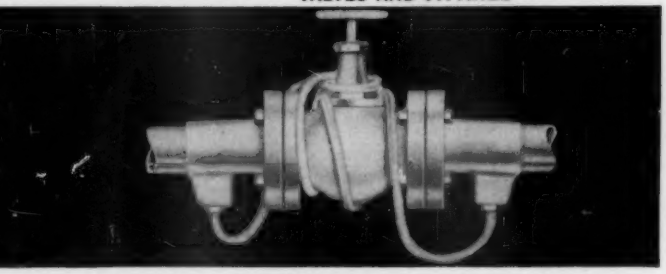
*Unitrace may be bent in any direction to these radii provided reasonable tooling is employed.

Average coefficient of thermal expansion (per °F)	−58 to +68°F	68 to 212°F	68 to 392°F	68 to 572°F
	12.1×10^{-6}	13.0×10^{-6}	13.6×10^{-6}	14.2×10^{-6}

FLANGED CONNECTIONS

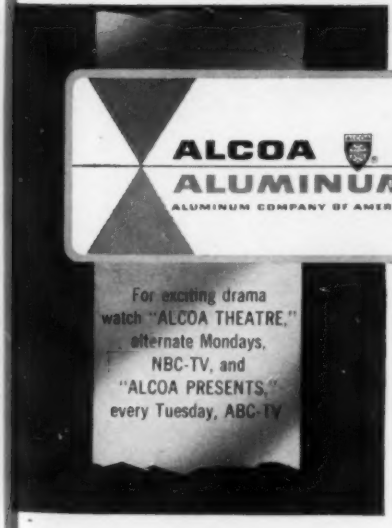


VALVES AND FITTINGS



Special cast Unitrace flanges are available in alloy A356-T7. Bolt holes mate with standard 150-lb ASA pipe flanges for easy joining to other piping and equipment. For joining, the Unitrace trace line is cut back a short distance. The Unitrace is inserted into the flange and welded at the front face and neck of the flange using 4043 weld wire. Adapter flanges are available for joining different sizes of Unitrace.

Through use of Alcoa Unitrace flanges, valves and fittings can be incorporated into a Unitrace system. Tapped openings are provided in the steam chamber of Alcoa Unitrace flanges to facilitate attachment of jumper connections to traced valves and fittings. Alcoa offers Unitrace elbows with a 3x centerline radius. Several valve manufacturers offer steam-traced valves of aluminum.


ALCOA
ALUMINUM
ALUMINUM COMPANY OF AMERICA
For exciting drama watch "ALCOA THEATRE," alternate Mondays, NBC-TV, and "ALCOA PRESENTS," every Tuesday, ABC-TV

Aluminum Company of America
876-G Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature on Alcoa Unitrace and other aluminum piping for the processing industry.

- ☐ 10186 Alcoa Aluminum Heat Exchanger Tubes
- ☐ 20437 Aluminum Alloy Heat Exchangers in the Process Industries
- ☐ 10460 Process Industries Applications of Alcoa Aluminum
- ☐ 10415 Welding Alcoa Aluminum
- ☐ 34-10418 Alcoa Unitrace: Combines Piping and Tracing in One Unit

Name_____

Company_____

Title_____

Address_____

City_____

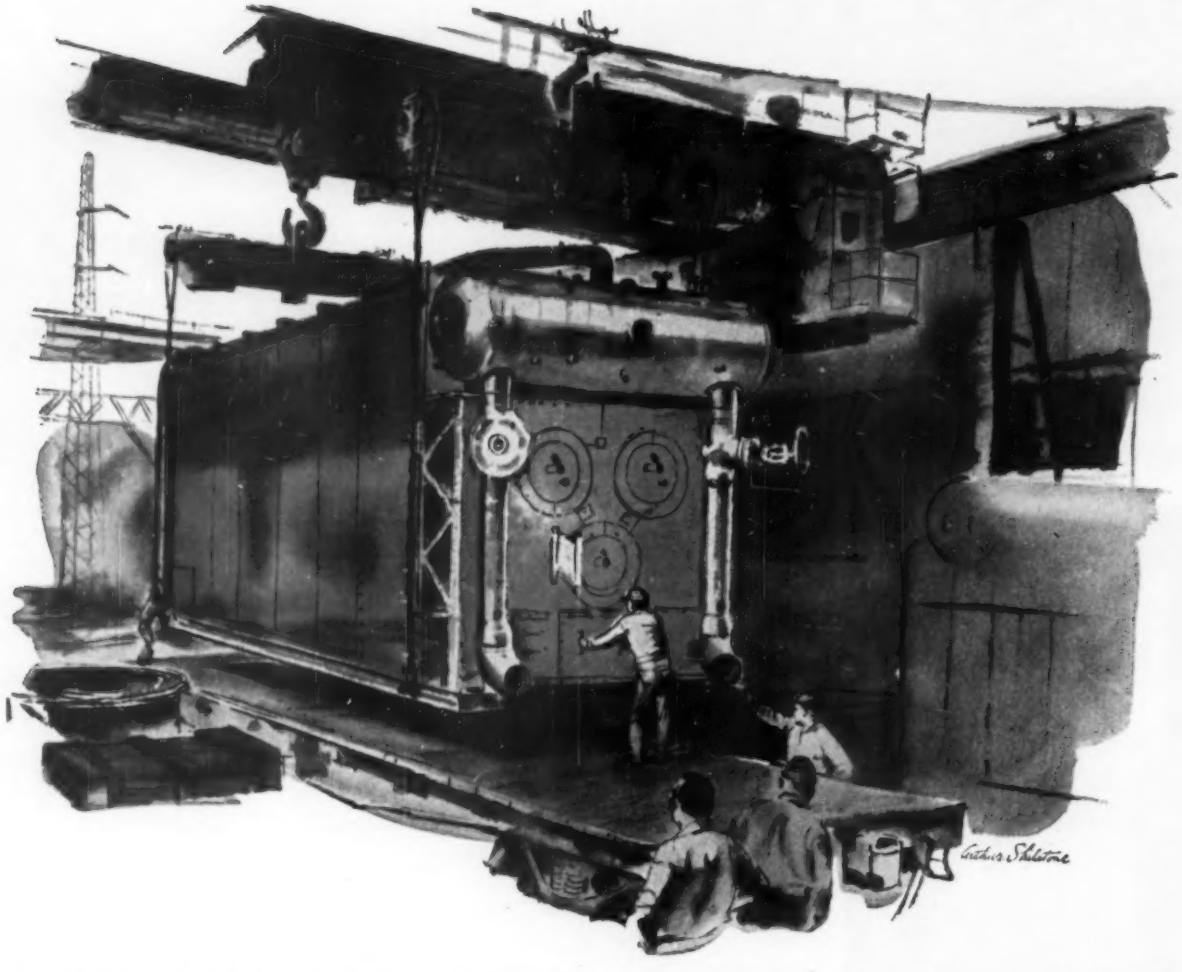
State_____

For more data circle 506 on Post Card

RECORD-BREAKING HIGH
. . . wrapped in a Package

Shown below is the world's highest-pressure "package" boiler — a C-E Controlled Circulation Unit — Type PCC. It is designed to produce steam at a pressure of 1800 psi and 1050 F. Now installed at the General Electric Company plant at Fitchburg, Massachusetts, it provides steam for special testing purposes.

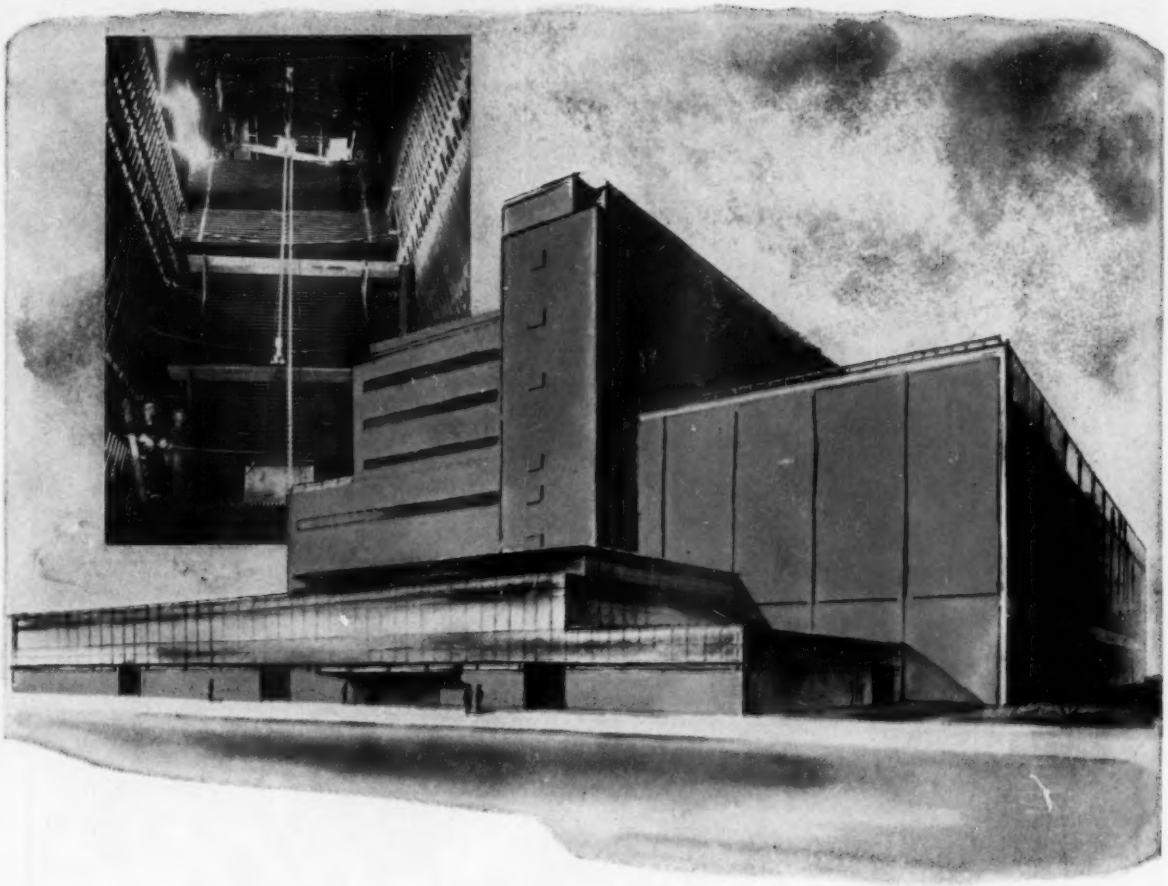
The plant on the facing page is the Eddystone Station of the Philadelphia Electric Company. It contains a C-E Sulzer Monotube Steam Generator, a small portion of which is shown in the upper left corner of the drawing. Later this year, when this boiler is placed in service, it will produce steam at the highest pressure and temperature ever used in commercial power practice — 5000 lb per sq in and 1200 F.



ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

PRESSURE BOILERS by C-E

. . . or filling a Plant



The facts on the opposite page are of significance to you. They are part of the long list of C-E "firsts"—a list which includes the world's first boiler designed to produce as much as 3,850,000 lb steam per hour—and the world's largest package boiler, which produces 120,000 lb steam per hour. They give further evidence that—even in the biggest sizes and in the highest pressure ranges—C-E offers the most advanced designs for all steam requirements and with all fuels. To date, 38 C-E units have been purchased to provide 2400-pound pressure steam—or above—at the throttles of turbine-generators that have an aggregate capacity of about 8-million kilowatts. Fourteen of these units are already in service—one for a period of over three years.

When you are in the market for high-pressure boilers, it will pay you to contact the organization which offers you the broadest experience in the field—Combustion Engineering. In addition to these high pressure units, C-E also offers boilers in all types and sizes with capacities ranging from 4000 pounds of steam per hour, up to the largest in the world. All are designed to meet your needs reliably, efficiently and economically.

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N.Y.

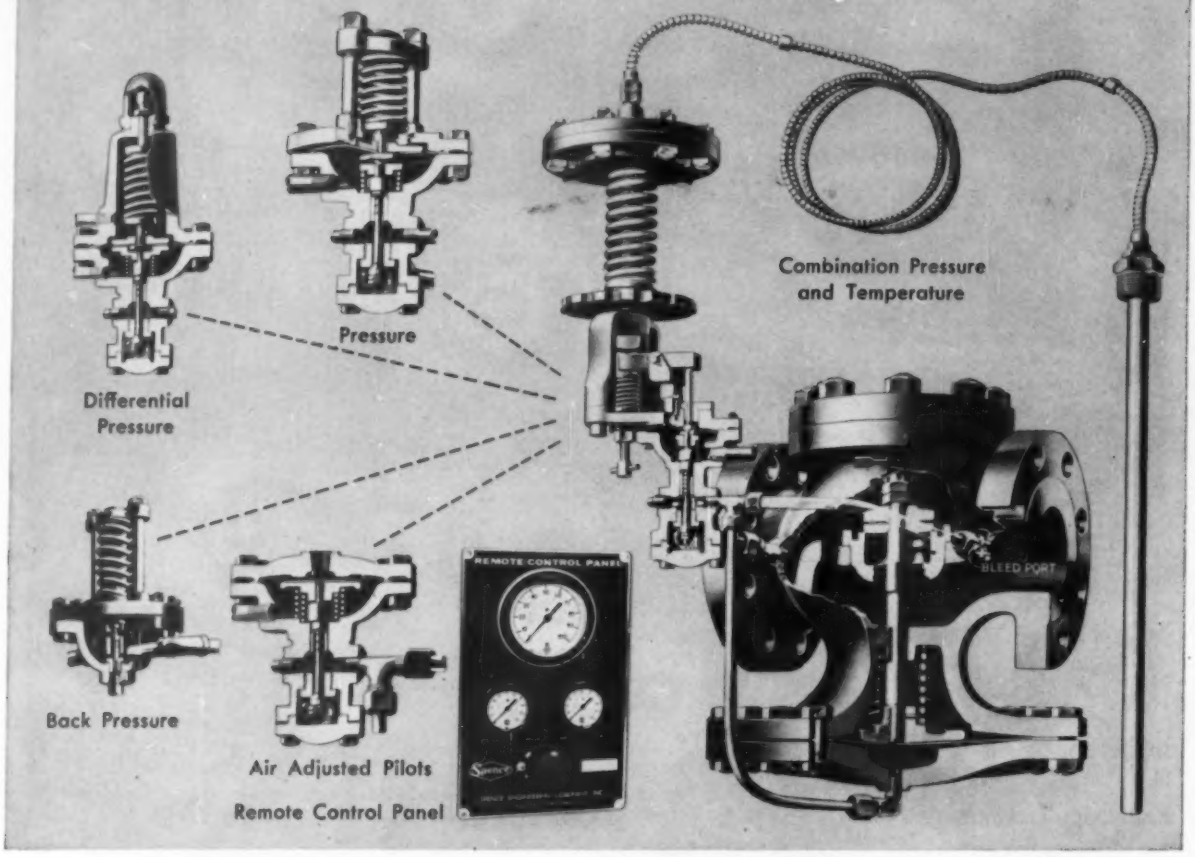
C-219

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more data circle 507 on Post Card

VALVE TIPS:

All Pilots Fit All Main Valve Sizes Downtime, Maintenance, Inventory Reduced



Let's start off by admitting there's no such thing as a "maintenance-free" regulating valve. Any valve that automatically controls temperatures or pressures within close limits can be affected by dirt in steam lines.

If trouble does develop, engineers want a regulator they can get back on the line — fast. That's one reason why more engineers are standardizing on Spence Regulating Valves with externally mounted pilots. The simple test of disconnecting the external bends establishes whether the trouble is in the main valve or the pilot.

If the main valve is the trouble spot, it can be maintained without removing the valve body from the line. If the pilot is the trouble spot, it is easily removed for cleaning. However, if production downtime is a strong factor, the fastest method is to install a spare pilot and it is inexpensive.

All Spence pilots fit all sizes of Spence main valves. If you have twenty pressure regulators, for instance, all you need is *one spare pilot*. It will fit all main valve sizes from ¼" to 12".

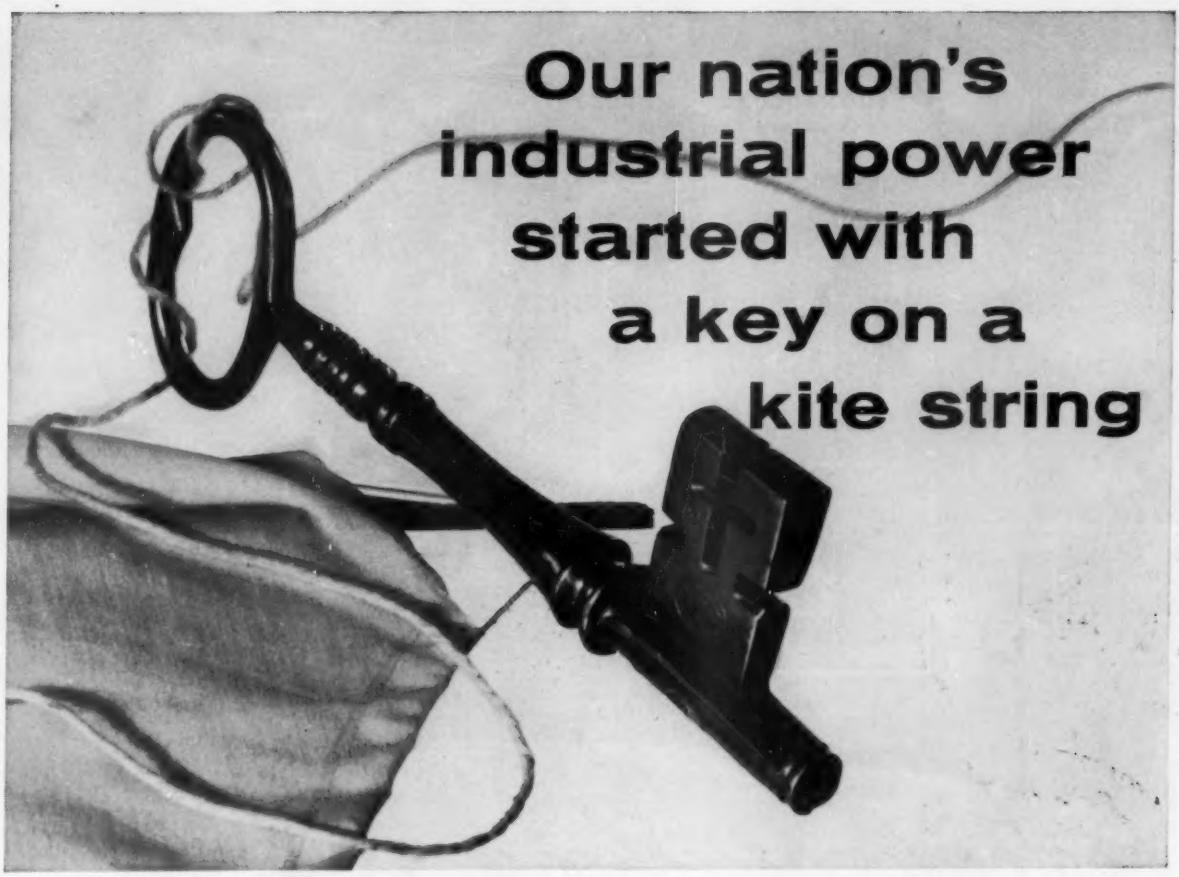
Another advantage of the Spence design is the external pilot is interchangeable. You can change the function of a regulator by merely changing the pilot. In many plants this can represent an important factor in reduced inventory costs because you only carry a few inexpensive extra pilots instead of complete regulators. Obviously, there is also a considerable savings in labor costs when a valve can be converted, in the line, from a temperature regulator to any one of various pressure regulators.

The pictures above show a few of Spence's wide line of automatic regulators. For more information write for Bulletin TE.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York 85-148

For more data circle 508 on Post Card

Our nation's industrial power started with a key on a kite string



A key on a kite string and a bolt of lightning marked the first step toward the wonders of the Electric Age. Here was power . . . *unlimited power* to drive the machines that produce the necessities and luxuries of modern life at a cost within the reach of all.

This power was unharnessed until a breed of forward-thinking men risked their money, time and energy to build a great independent private electric utility industry. Created under our system of free enterprise, it has been a vital factor in bringing America the highest standard of living in the history of mankind.

The citizens of this country have every reason to appreciate and support this great basic industry.

Coal generates more electricity than all other fuels and water power combined. Peabody Coal Company supplies coal to many of the nation's leading electric utilities. Peabody is pleased to have this part in helping these great utilities bring you efficient, dependable power . . . at a price you can afford to pay.

Get your free booklet, "This Is Peabody Coal Company," and learn more facts about PEABODY and its complete coal service. Write Department PE.

power for progress

PEABODY COAL COMPANY

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Professionals choose ERIE CITY KEYSTONE STEAM GENERATORS

● Consulting Engineers and their staffs are actively engaged in selecting and coordinating the most dependable equipment available. We are proud of the confidence they have placed in Erie City.

Built-in quality is the backbone of confidence — and hundreds of Keystone Steam Generators are in service today because they incorporate proven quality design features.

Design features such as tangent furnace and outer wall tubes plus double steel encased insulation keep outer casing cool to the touch. The top smoke outlet eliminates the inconvenience of a hot stack in the aisle, minimizes required floor space and reduces building costs. Keystones have no baffles or headers which generally are a source of troublesome maintenance.

These features and many more have proved the Keystone to be a safe, highly efficient steam generator with plenty of reserve power. Write for our comprehensive Bulletin SB-5992-G.

LOW EXIT TEMPERATURES AND HIGH EFFICIENCIES ARE STANDARD WITH THE KEYSTONE

You can depend on ERIE CITY *Since 1840* *for sound engineering*

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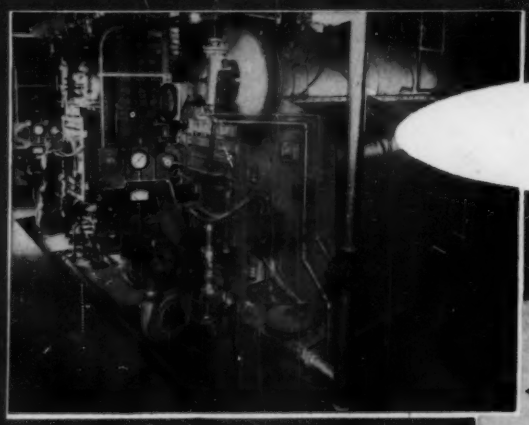

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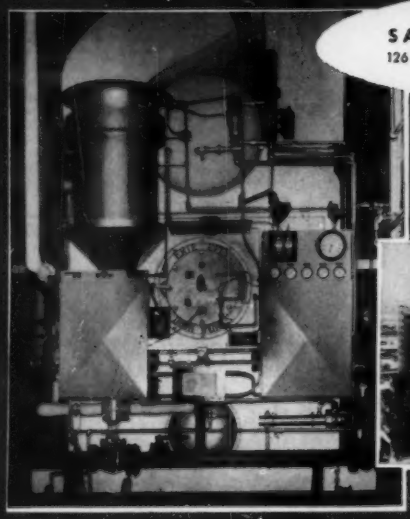

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... City, Oklahoma
... h.p. Keystone Steam
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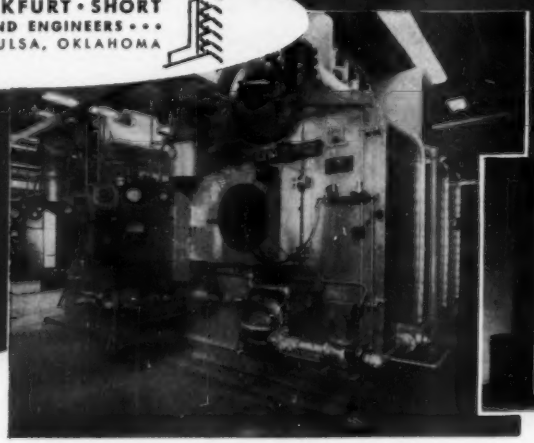
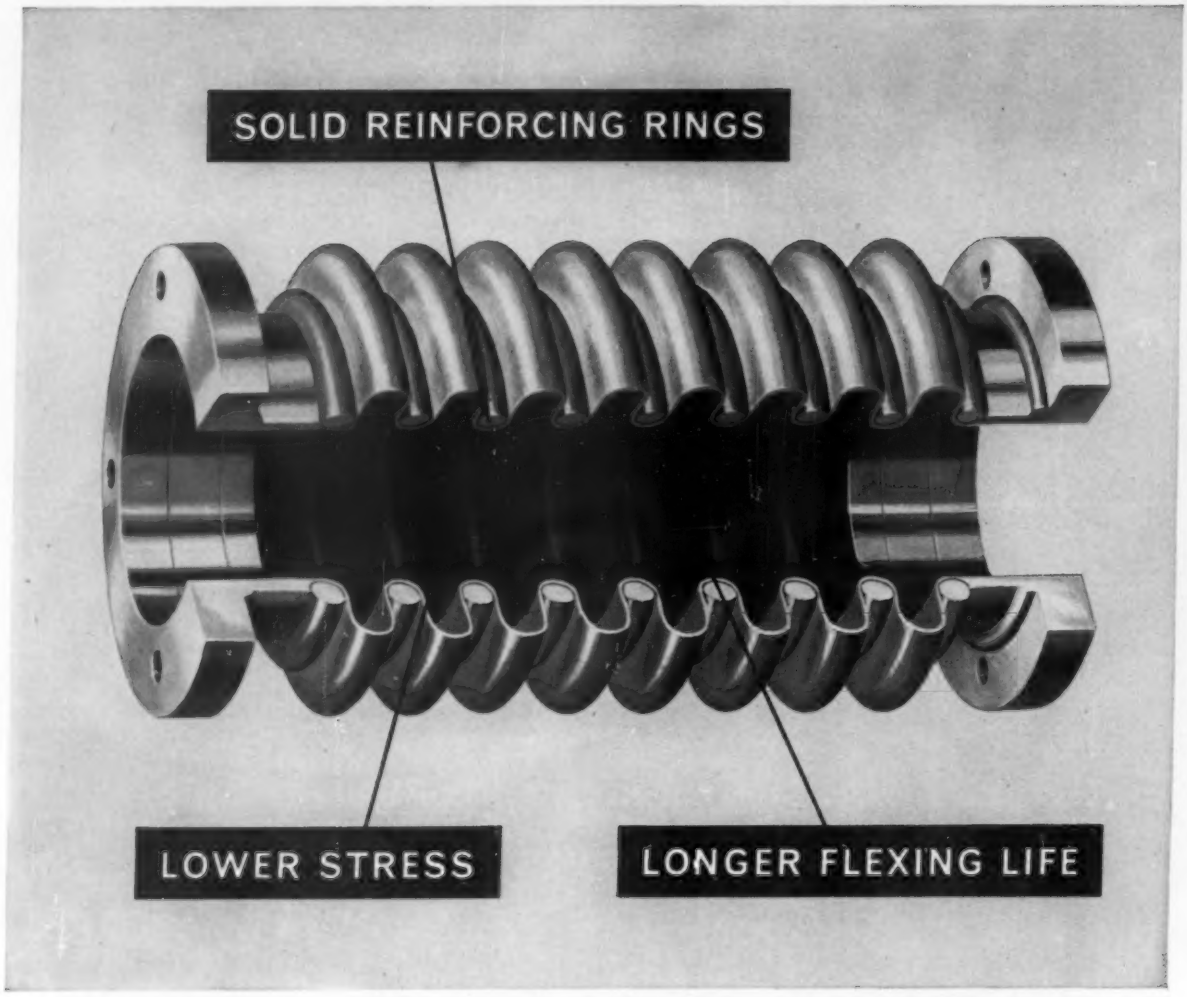


For more data circle 510 on Post Card



NEW SOLA-FLEX® JOINT!

Unique solid-ring-supported joint withstands pressures to 1200 psi

SOLAR'S NEW RING-SUPPORTED expansion joints offer advantages found in no other design. Reinforcing rings are a solid bar formed integrally with the bellows element—allowing 100% weld penetration of the cross section area. Precise forming and sizing of rings eliminate pre-operating radial clearance commonly found in other types. Result: higher working pressures, lower stress, longer flexing life with new ring-supported Sola-Flex expansion joints.

Solar manufactures the most comprehensive line of expansion joints in the world. They are made from a wide variety of stainless and high alloys for important nuclear, missile and industrial applications—in sizes ranging from ½ in. to 35 ft in diameter. They are built for service from –320F to 1200F. And they tame "hard-to-handle" pressures up to 3500 psi for special applications. Delivery is fast.

A new pamphlet describes Solar's complete line of expansion joints. Write for it to Dept. G-125, Solar Aircraft Company, San Diego 12, California.

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AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

ENGINEERS WANTED! *Challenging projects, unlimited opportunities with Solar. Write today!*

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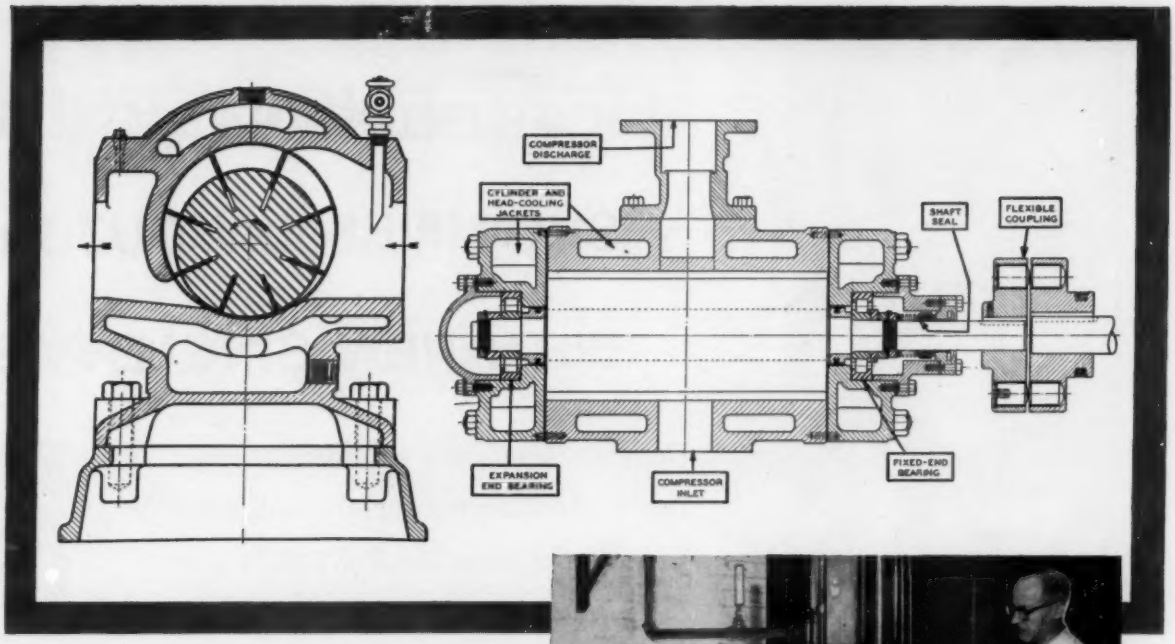

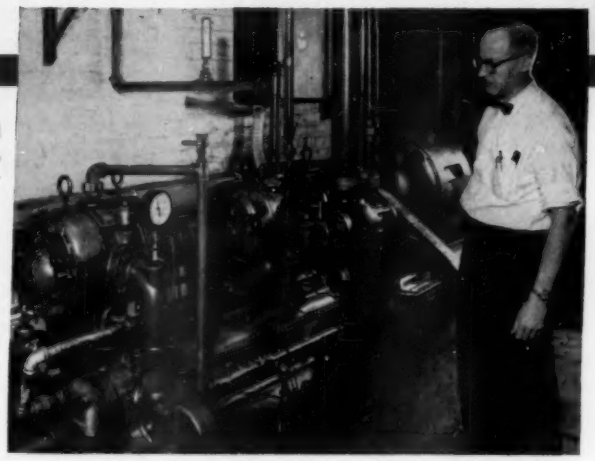

Hard service never affected this Fuller rotary's original output—230 cfm. of air at 90 lb. G., reports Mr. Schott, chief engineer, Thomas C.Wilson, Inc., Long Island City, N.Y.

FULLER ROTARY COMPRESSOR RUNS 13 YEARS WITHOUT DOWNTIME

A Fuller rotary at Thomas C. Wilson, Inc. got its first maintenance shutdown recently, for renewal of roller bearings and rotor vanes—after running without downtime since 1945.

4 years of 24-hour service. The Wilson plant makes tube cleaning equipment, tube expanders and portable pneumatic tools, and so makes heavy daily demands on shop air. For the first four years, three-shift operation kept the Fuller rotary running round the clock. Since 1949, it's been working eight-hour shifts.

Simple design means trouble-free service. Besides bearings, the only moving parts in a Fuller vane-type rotary compressor are the cylinderical rotor and the blades. These compensate for wear automatically. Cylinder head slips off, permitting blade and bearing inspection in a matter of minutes.

Compact and vibration-free. Direct-drive system saves space. Simple, rugged design gives constant service without extensive supervision. Thus, Fuller rotaries can be installed out-of-the-way—on upper floor, on balconies, in basement corners, using low-cost, light-weight foundations.

1189
C-340

Write today for detailed information on the full line of Fuller rotary compressors for in-plant services, gas gathering, and industrial refrigeration.

FULLER COMPANY
GENERAL AMERICAN

FULLER COMPANY
150 Bridge St., Catasauqua, Pa.
SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
Birmingham • Chicago • Kansas City • Los Angeles • New York • San Francisco • Seattle

Fuller
....pioneers in harnessing AIR

PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

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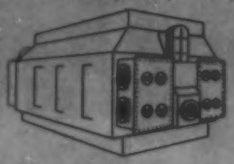
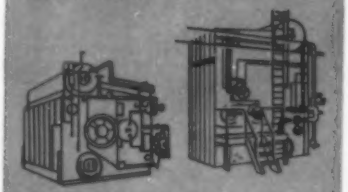
Power Plant Products

HEAT ENGINEERED BY FW



CONDENSERS and HEATERS—Condensers custom designed for individual plant requirements. All-welded high and low pressure feedwater heaters.



PACKAGED and FIELD-ERECTED BOILERS—Compact, economical, standardized units in capacities from 10,000 to 450,000 lb/hr oil, gas or pulverized coal fired.

LARGE STEAM GENERATORS—Designed to meet all requirements for Central Station or Industrial power plants, in single- or twin-furnace designs, with or without reheat or dual circulation.

COOLING TOWERS—Induced draft counter flow towers of all-redwood construction for maximum dependability and long service.

NUCLEAR COMPONENTS—Heat exchangers, steam generators, pressurizers, reactor vessels, separately-fired superheaters for stationary and marine power plants.

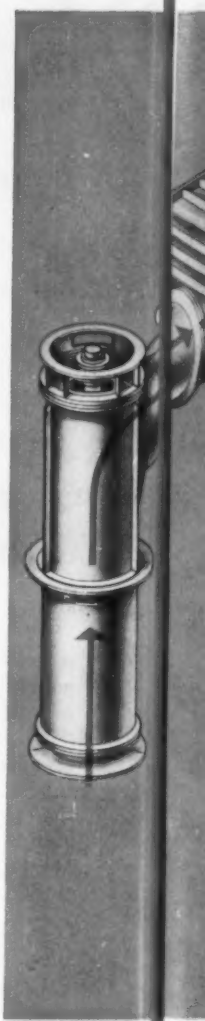
PULVERIZED FUEL SYSTEMS—Completely engineered systems utilizing FW ball mill or MB planetary roll and table pulverizers.

HEAT ENGINEERING

SIMPLIFIES LAYOUT and

WITH NEW SINGLE-PASS,

Compact shells use economical short tubes, eliminate two waterboxes, simplify valving. Balanced back pressure and built-in backwashing system offer further advantages for Alabama Power Company's Barry Steam Plant, Unit No. 3.



Problem: Alabama Power Company and Southern Services, Inc., Engineers, specified that the dual exhausts of the 225,000 kw turbine be handled with condenser tubes at right angles to the turbine shafts —in the tight confines of a plant extension for Barry Steam Plant, Unit No. 3.

Solution: Heat Engineering by Foster Wheeler

By application of the established principles of Foster Wheeler condenser design, a most economical arrangement for a twin bottom-exhaust turbo-generator set with tubes at right angles to the turbine shafts was provided. It features short tube lengths, complete backwashing and a minimum number of waterboxes for a twin-shell design.

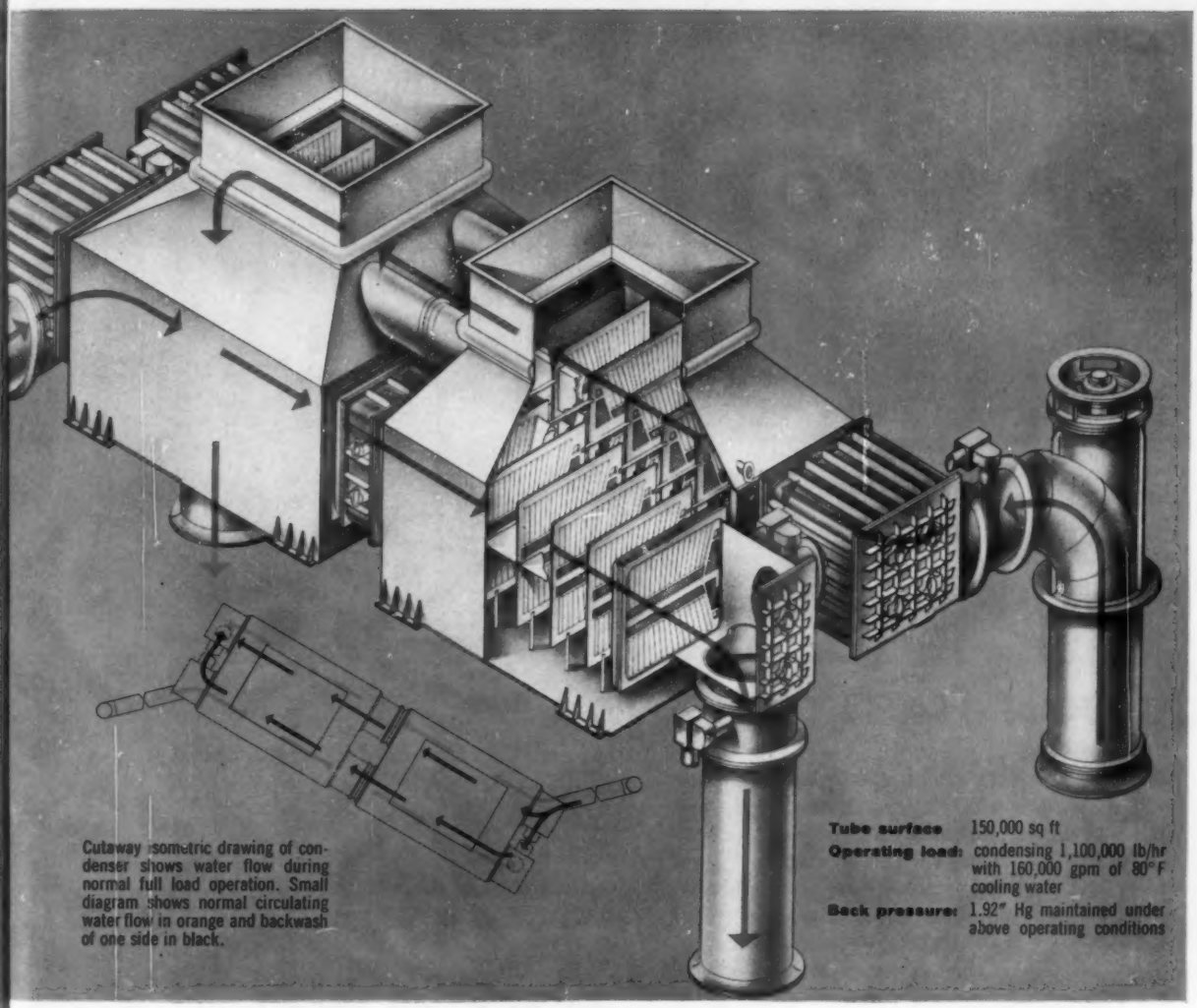
Backwashing of the tube sheets is obtained with only six valves, two of which are the normal circulating pump shut-off valves. This valving arrangement also allows the complete condenser to be operated at light loads with only one circulating pump.

In design advances such as this, you see Heat Engineering at work. This is the concept you can expect—combining new and original ideas with proved engineering principles—when Foster Wheeler serves you. *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.*

BY FOSTER WHEELER

REDUCES CONDENSER COSTS

COUNTER-FLOW DESIGN



Cutaway isometric drawing of condenser shows water flow during normal full load operation. Small diagram shows normal circulating water flow in orange and backwash of one side in black.

Tube surface 150,000 sq ft
Operating load: condensing 1,100,000 lb/hr with 160,000 gpm of 80°F cooling water
Back pressure: 1.92" Hg maintained under above operating conditions

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

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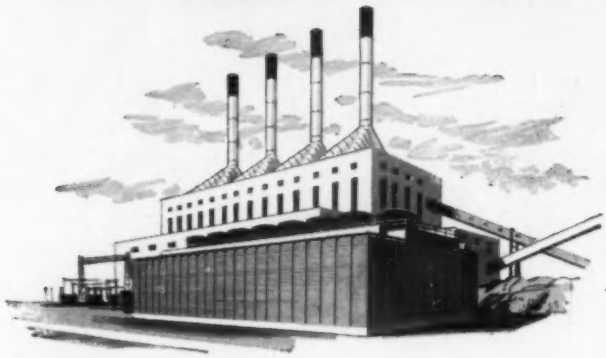
WATER PROBLEMS IN . . .

heat exchangers?

pipe lines?



cooling towers?

CALGON HAS THE ANSWER

Corrosion and other water damage to key points in cooling and service water systems can tie up an entire plant. Costly equipment can be damaged beyond repair. Replacement costs and the losses caused by unscheduled outages far outweigh the modest cost of adequate protection.

Call on Calgon Engineering Service to insure protection of the entire system. From cooling towers on through, the Calgon engineer can save you money and time. Experience with every type of water problem in all parts of the country, backed by complete laboratory facilities, is at your service.

Corrosion control with Calgon* is only one of the many services available. A letter or phone call will bring a man with the water problem answers to work for you.

*Calgon is the Registered Trademark of Calgon Company for its sodium phosphate glass (sodium hexametaphosphate) products. The use of polyphosphates for the prevention of corrosion is covered by U. S. Patent 2,337,856.

CALGON COMPANY

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PA.

In Canada: Hagan Corporation (Canada) Limited, Toronto

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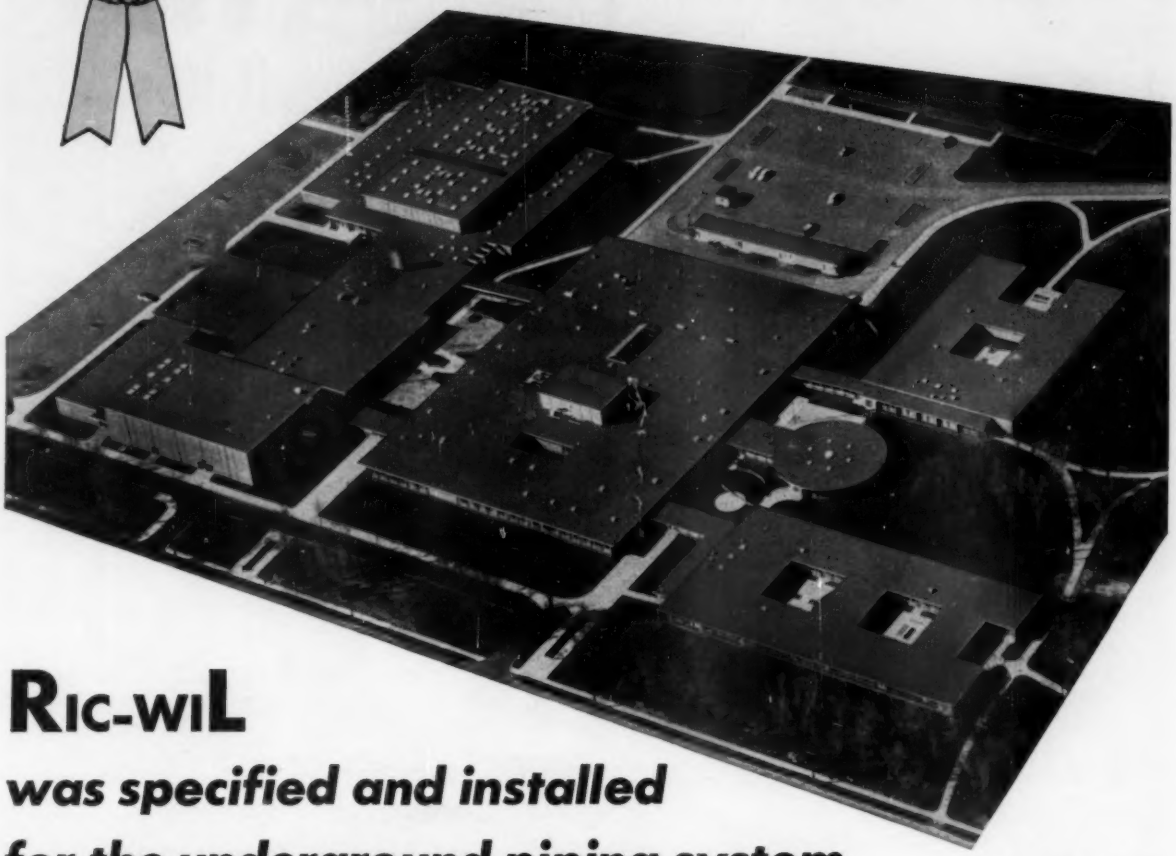
at Award Winning Linton High School...



RIC-WIL
was specified and installed for the underground piping system

Architects: Perkins and Will; Ryder & Link
Consulting Engineer: E. R. Gritschke
Contractor: Tougher Plumbing & Heating Co.

RIC-WIL is indeed proud to be a part of the Linton High School Project. All of the firms participating in the annual awards are to be congratulated and encouraged in promoting better design of educational buildings. For over 49 years RIC-WIL has supplied the distribution piping systems for educational buildings through the United States, Canada and many foreign countries. These piping systems have proved to be the finest in Thermal efficiency and mechanical strength. Complete information is available on the many types of systems. Write, wire or phone for literature.

See our catalog in Sweets

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency
SINCE 1910

RIC-WIL PREFABRICATED INSULATED PIPING SYSTEMS

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WESTERN STATES: WESTERN RIC-WIL COMPANY, NEWARK, CALIF.
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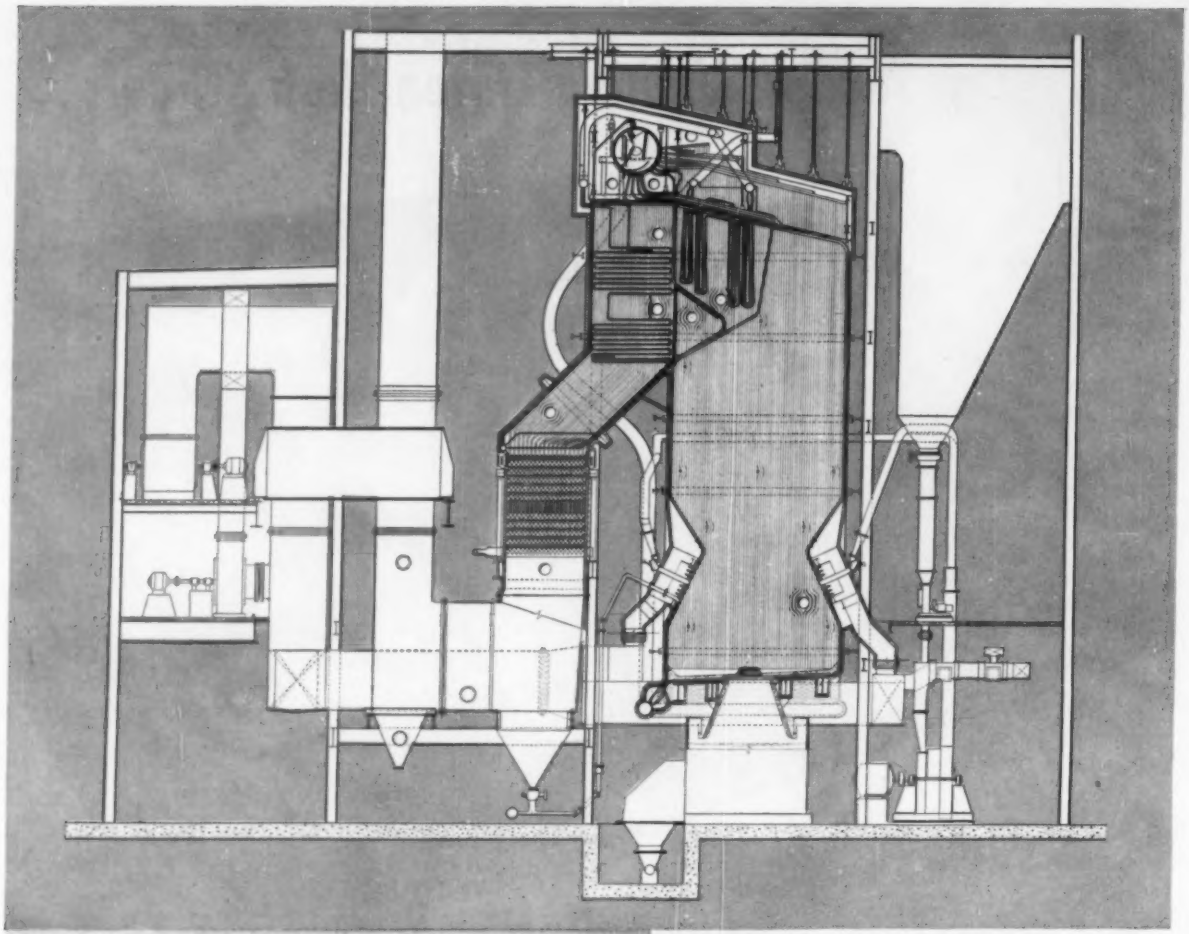
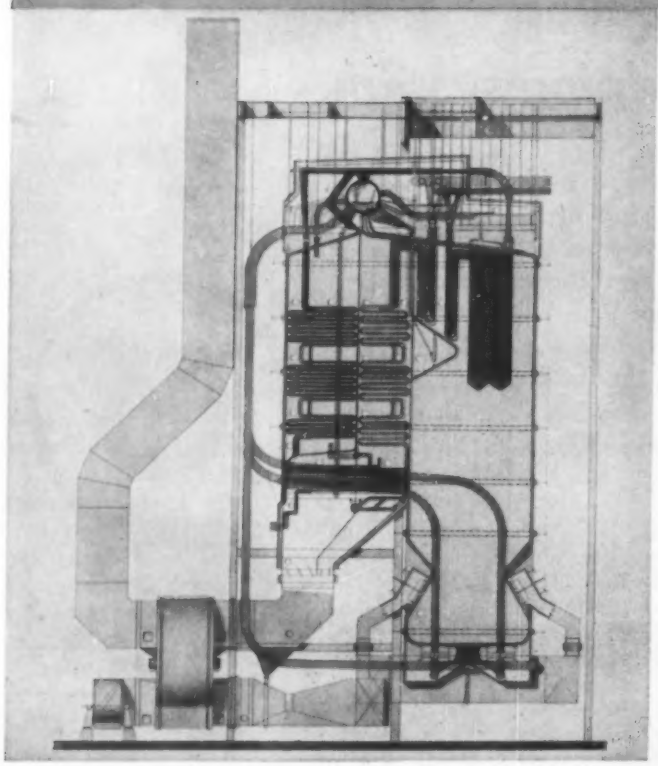




A Progressive Chemical Company
One 400,000 lbs/hr Turbo Furnace Boiler: 830 F — 1250 psig. Unit is fired by pulverized coal from three Riley Pulverizers. A second Turbo Furnace Boiler of 600,000 lbs/hr has been purchased for a second plant at this location.

A Louisiana Public Utility
One 1,550,000 lbs/hr Turbo Furnace Boiler; 1005 F superheat, reheat — 2175 psig. This unit has a furnace 55 feet wide with no water cooled platens or dividing walls. Fired by natural gas. Can be converted to coal quickly and at low cost.

A Prominent Manufacturer of Electrical and Electronic Equipment
One 150,000 lbs/hr Boiler: 835 F — 900 psig; Fired by pulverized coal. One Duplex Riley Pulverizer.

For the full operating facts of Riley Turbo Furnace Boilers consult your Riley representative.

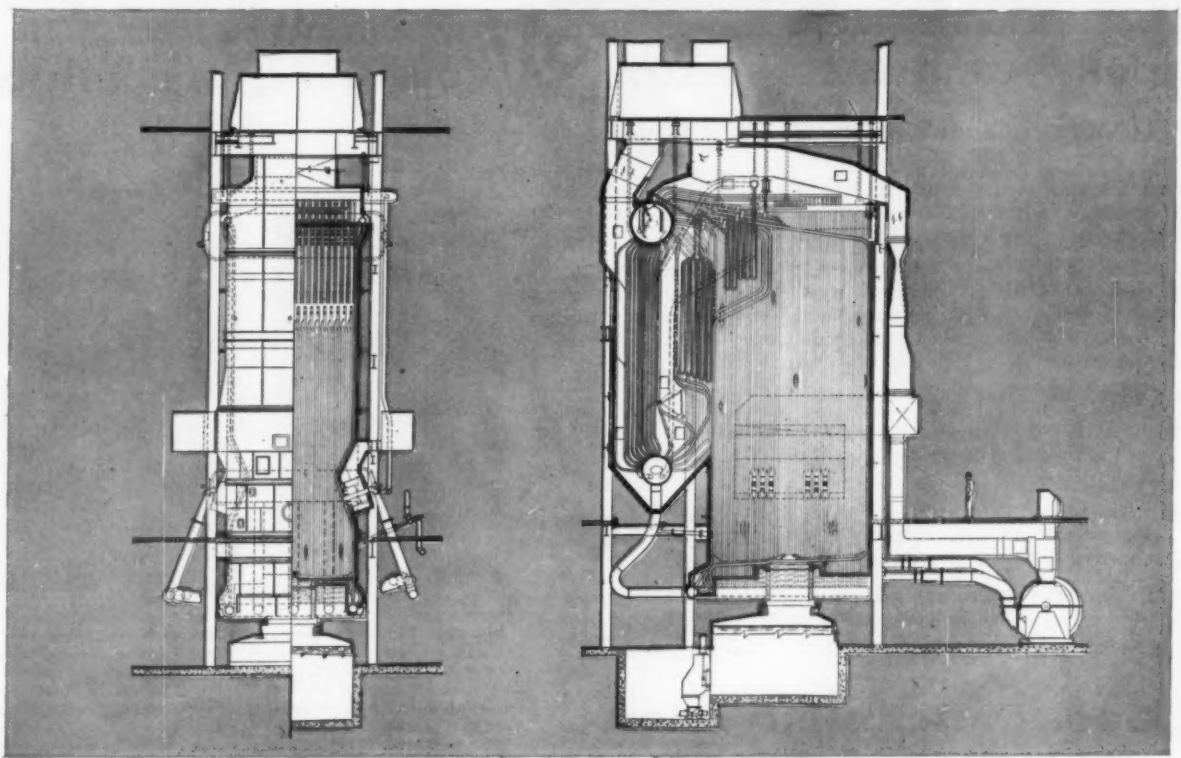
These Three Companies Selected The
RILEY TURBO FURNACE
Because Of These Outstanding Performance Characteristics

- Eliminates the flyash disposal problem
- Clean furnace walls eliminate necessity of wall deslagging equipment
- High operating efficiency — minimum carbon loss — low excess air
- Uniform distribution of furnace gases across full width of the superheater with minimum variation in metal skin temperatures from side to side
- Maximum utilization of waterwall surface
- Economical and quick conversion from gas and oil firing to coal
- Because of performance characteristics, the Riley Turbo Furnace can be operated at higher heat releases: The size of the unit is reduced thus reducing building costs and permitting higher capacity within a given space
- A wide furnace is possible without need for dividing walls
- One level firing reduces expense for walkway systems
- Provides ease of observation and operation

FOR TURBO FURNACE DETAILS — WRITE RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS

A survey of your plant by a qualified consulting engineer could show ways of making surprising savings in your power costs.

RILEY
STEAM GENERATING & FUEL BURNING EQUIPMENT



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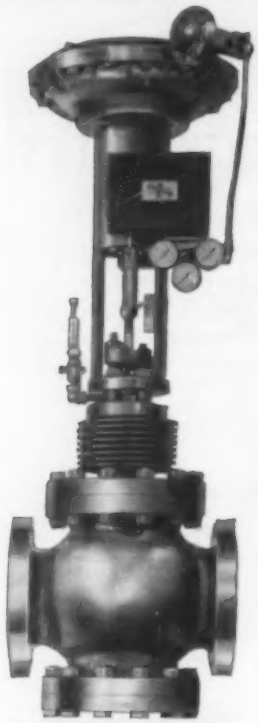
COPES VULCAN

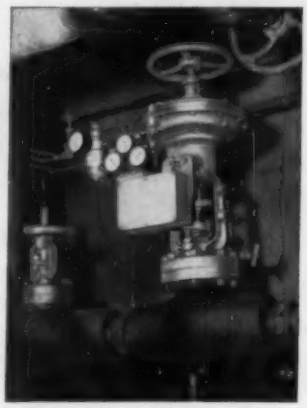
BLAW-KNOX

How Copes-Vulcan control systems boost power plant efficiency



Type CV-D (diaphragm-operated) valve serves a broad variety of applications in sizes up to 12 inch. Optional features include: cooling fins and stuffing-box lubricator to maintain low friction over long packing life, auto-lock, top or side-mounted handwheel for emergency operation.

Valves used in modern combustion control system. One diaphragm-operated valve is used as a single-seated fuel return control valve (left) while another controls the speed of the turbine driving the forced-draft fan (right).



Efficient feedwater-flow control system uses a Type CV-D valve equipped with positioner, air lock, and emergency handwheel operator (left). Another diaphragm-operated valve trips automatically if fuel-oil line pressure drops below a safe limit (right).

Copes-Vulcan Regulator Valves bring precision control to exacting jobs...

Designed for superior accuracy and long range dependability, Copes-Vulcan valves establish new standards of efficiency for pressure, temperature, flow, and level control.

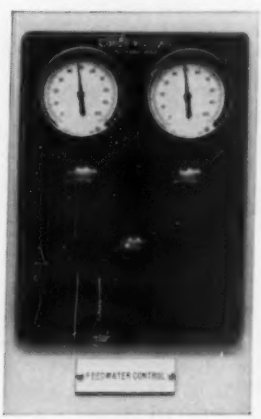
To assure trouble-free performance, Copes-Vulcan custom designs each valve to suit your most rigid control requirements. The kind of fluid—its flow, pressure, and temperature—are all studied before a recommendation is made. Port area and style are selected on the basis of careful research.

The Copes-Vulcan line includes the following valves.

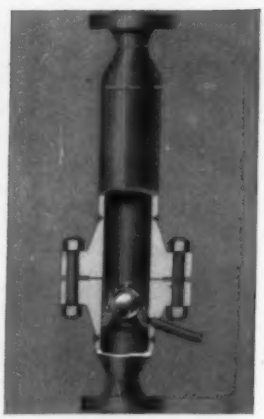
Diaphragm valves (Type CV-D) provide greater versatility . . . have excellent rangeability . . . may be direct or reverse acting.

Piston-type valves (Type CV-P) offer simplicity of design . . . ideal where valve-operating force must be unusually high, where positioning must be precise.

Nuclear valves for ships, atomic plants, and test reactors. Supplying valves for these advanced projects offers proof of the acceptance of Copes-Vulcan's skill and integrity.



Pneumatic control stations assure combustion control efficiency. Copes-Vulcan stations offer simple automatic-to-manual selection without complication of seal balance. Transfer is "bumpless" without process disturbance. Write for Bulletin 1031.



Desuperheater improves temperature control. New Copes-Vulcan Variable-Orifice Desuperheater holds reduced steam temperature constant less than twenty feet downstream from desuperheater outlet, even over a 50-1 load range. Write for Bulletin 1037.

Copes-Vulcan Division
BLAW-KNOX COMPANY
Erie 4, Pennsylvania

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HELPFUL BULLETINS

MECHANICAL POWER TRANSMISSION

101 Power Transmission Equipment — Featured in 48-pp Book 2747 is a line of gearmotors, motogears and fluid drives for power transmission applications. Advantages of design and operation are detailed, and comprehensive selection tables are included, as well as photos, cutaway views and diagrams showing component features. Link-Belt Co.

102 High Speed Drives — High speed gear drives for special test stands, industrial applications, pipeline and air conditioning service are illustrated and described in 20-pp Bulletin 5904. Contains engineering details, dimensions, rating tables and data. Western Gear Corp.

103 Timing Belt Drive — Described in Bulletin 20B8760 is a timing belt drive constructed with steel cable cords imbedded in Neoprene fully molded with nylon base fabric. Advantages are detailed. Allis-Chalmers Mfg. Co.

104 Thrifty Speed Reducers — Bulletin 5908, about 20 pp, contains engineering information and specifications on SpeedMaster vertical-helical speed reducers offering economy of original and operating costs. Covers both double and triple reduction units and includes selection instructions covering many types of installations. Western Gear Corp.

105 Clutch-Pulley Package — Ten-pp Electro-Sheave Brochure WEB P-52 describes in detail a clutch-pulley package for direct installation on standard electric motors from 1 to 25 hp. Large cutaway illustrates design features. Included are sections on description, operation, dimensions and selection. Warner Electric Brake & Clutch Co.

106 V-Belt Pulleys — Contained in this product bulletin are specifications on standard single-groove V-belt pulleys for fractional horsepower equipment. Dimensional diagrams illustrate details. The Nagel-Chase Mfg. Co.

107 V-Belts and Fasteners — Bulletin V-227 contains 6 pp of detailed information on V-belts and V-belt fasteners. Describes use of fasteners with open-end V-belting, how to determine belt lengths, and includes V-belt replacement charts, and other data. Flexible Steel Lacing Co.

108 Magnetic Brakes—Bulletin 5000 illustrates and describes construction features and advantages of company's magnetic brakes covering the range of 600-series motors. Illustrates maintenance procedures, and contains selection charts for matching brakes to specific motors. The Electric Controller & Mfg. Co., Div. Square D Co.

PUMPS, COMPRESSORS

109 Submersible Pumps — Bulletin 203 describes horizontal in-line submersible pumps for booster service. Applications are detailed and advantages described. Layne & Bowler, Inc.

110 Close-Coupled Pumps — Catalog D-101 describes small centrifugal pumps for air conditioning systems, lawn sprinkling systems, small cooling tower systems etc. Contains outline dimensions, design and material data and performance curves for these versatile close-coupled pumps. C. H. Wheeler Mfg. Co.

111 Diffusion Pump — Featured in this product bulletin is a diffusion pump which obtains pressures of 10-6 mm of mercury or less after only a few minutes of pumping in systems up to five liters of total volume. Gives full details and illustrates a three-stage pump and gages for measuring low pressure. Delmar Scientific Laboratories.

112 Heavy Duty Compressor— Eight-pp Bulletin 350 describes and illustrates a horizontal, water-cooled, single-stage, heavy duty compressor designed to fit most compressed air applications. Photos, line drawings and cross-sectional views illustrate construction details. Pennsylvania Pump & Compressor Co.

VALVES, PIPE, TRAPS, FITTINGS

113 General Purpose Valves — Catalog KS-1 covers company's small valves for general application. Information pertaining to working pressures, specifications, construction features, and suggested applications is included. Kerotest Mfg. Co.

114 Three-Way Valves — Bulletin 8F describes three-way feedwater heater bypass valves for regulating boiler feedwater flow. Includes sectional drawings and information on design features, materials of construction, operation and application, as well as piping diagrams. Schutte and Koerting Co.

115 Corrosion-Resistant Valves — Featured in 24-pp Catalog 425 are stock, wedge gate, check, throttle and digester cap valves made of corrosion-resistant materials. Includes tables giving critical dimensions and material specifications. W. G. Rovang and Associates, Inc.

116 Non-Return Valve — Featured in 6-pp Bulletin S-2 are of single acting non-return valves for control of boiler pressure. Advantages of design and operation are detailed, and schematic diagrams showing component features are included, as well as complete specifications. Golden Anderson Valve Specialty Co.

117 Safety Relief Valves — Comprehensive Catalog 88, 84 pp, gives detailed information on safety relief valves for power, processing and general industrial services. Extensive engineering charts and data, together with valve discharge capacity tables for liquids, air and gas, and steam are included. Valves from ½- to 6-in. sizes, of bronze, semi-steel or steel, are shown and described. Valves are for maximum service ranges from 20 to 3000 psig and 300 to 750 F, for operations utilizing liquids (including viscous types), steam, air vapors, gases and ammonia, as well as for vacuum relief. Marine & Industrial Products Co.

118 Molded PVC Valves — Six-pp Circular 601 describes Luncor valves, all-molded PVC valves. Features table showing recommendations for handling various corrosive fluids, plus information on sizes, weights and dimensions of both screwed and socked end valves, as well as installation data. Lunkenheimer Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 113 and 114.

119 Pipe Data — Technical Data Card TDC-191 contains the dimensions and weights per foot of pipe in sizes ⅛ through 36 in. for all schedules. Tubular Products Div., The Babcock & Wilcox Co.

120 Aluminum Process Pipe — Expanded availabilities of extruded aluminum pipe in Schedules 5, 10, 40 and 80 sizes are listed in 6-pp Form PT-893. Also covers performance characteristics, conversion factors, head loss curves, mechanical properties, and accessories. Booklet contains chart listing specific corrosion resistance recommendations. Kaiser Aluminum & Chemical Sales, Inc.

121 Steam Traps — Bulletin T-300 discusses typical applications, capacities and construction of company's steam traps for use in paper mills, chemical plants, textile mills, power stations, and all processes using steam. Includes tables of capacities, orifice sizes, parts and seat pressures and diagrams showing construction details. Ross-Midwest Fulton.

122 Seamless Welding Fittings — Bulletin FB-78 is a 12 pp guide to material selection of carbon, alloy and stainless steel welding fittings and flanges. Covers specifications and analyses, effects of alloying elements, mechanical properties and arc welding procedures. Tubular Products Div., The Babcock & Wilcox Co.

LUBRICATION

123 Lubricant Selection — Bulletin 121 is a lubricant selector chart for extreme pressure lubrication applications. Evaluates various types of lubricants as to temperature, environment, method of application, incorporation into common materials, and recommendations for various parts, operations and conditions. The Alpha-Molykote Corp.

124 Lubrication System — Eight-pp Bulletin 1451 describes lubrication and coolant systems for the steel, non-ferrous metal and paper industries. Featuring illustrations of recent installations, booklet includes specification tables and other data. Dravo Corp.

125 Colloidal Dispersion — Included in this company publication are illustrated articles about advantages of using 'dag'

brand colloidal and semi-colloidal dispersions for lubricants. A variety of typical applications are described and advantages detailed. Acheson Colloids Co.

ELECTRICAL

127 Synchronous Generators — Construction features of engine-driven synchronous generators are described in Bulletin 05B6139B. These generators come in standard ratings, speeds from 150 to 600 rpm, and with limitations due to rotor construction, from 720 to 1200 rpm. Bulletin also carries information on self-contained direct-connected generators and on belted exciters for use with engine-type generators. Allis-Chalmers Mfg. Co.

128 Small Motors — Eight-pp Catalog R-1 describes four types of a-c shaded pole, reversible, nongeared motors manufactured by the company. Complete information on performance characteristics, ratings, construction, dimensions and typical applications is included. Barber-Colman Co.

129 Selsyn Systems — Illustrated with photos and diagrams, 6-pp Bulletin GEC-1527 describes company's selsyn systems for a variety of applications. Operation, applications, and ordering instructions are included along with selection and mounting charts, torque-resistance curves, and dimension charts and drawings. General Electric Co.

130 Motors and Drives — Eight-pp Bulletin 2650 describes company's line of a-c and d-c standard motors, special motors, gear motors and adjustable speed drives. Gives information on units for a broad range of industrial applications. Summarizes characteristics and modifications for 20 basic types of motors and drives from ¾ to 2000 hp. The Louis Allis Co.

131 High-Speed Recloser — Low-cost, high-speed automatic reclosing protection for 23- to 46-kv circuits is described in 12-pp Bulletin 1560. Presents Type HVR reclosers with continuous current ratings from 100 to 400 amp, for protecting subtransmission lines and higher voltage distribution lines. Bulletin lists applications, gives specifications, and provides design and operating features. Also furnishes an analysis of performance testing, and installation information. I-T-E- Circuit Breaker Co.

132 High-Voltage Starters — Eight-pp Bulletin 8130 describes high-voltage starters for squirrel cage, wound rotor, and synchronous motors, in both air-break and oil-break forms, for use on 2200 to 4800-v systems. It also covers the various enclosures available, including those for outdoor installations as well as for hazardous locations. The Electric Controller & Mfg. Co., Div. Square D Co.

133 Manual Starters — Eight-pp Bulletin 11B1 introduces a line of manual starters, and contains data covering design, dimensions, ratings and prices. Starters described are rated through 7½ hp a-c and 2 hp d-c. This manual starter includes a "Jog-Run" accessory for either factory or field installation. Furnas Electric Co.

134 Mercury Switches — Twelve-pp Catalog 90b illustrates and describes a standard line of mercury switches for a-c or d-c applications. Included are photos, dimensions, electrical ratings, drawings, application information and technical data. Micro Switch, Div. Minneapolis Honeywell Regulator Co.

135 Pressure Switches—Catalog PS-59-60 is a 36-pp design handbooks featuring Meletron pressure switches. Each page describes a specific type (diaphragm, bourdon tube, or piston) and contains information on electrical and operating characteristics, ordering chart, adjustment instructions, spare parts table, dimension diagram. This catalog also serves as a manual of technical data and includes a glossary of terms, pressure switch selection chart, electrical rating tables, functional schematic symbols, trouble-shooting and maintenance checklist. Barksdale Valves.

. . . *Outstanding Among This Month's Catalogs*

136 Unit Substations — Tranfo-Units — packaged, compact unit substations — are described in 16-pp Bulletin 5604-1A. Provides basic design, application and specification information of value in selecting integrated combinations of equipment. Consisting of transformer with primary and secondary switchgear, these units permit voltage step-downs right at the load area. First section of bulletin covers general types of equipment available. Separate sections describe unit's three main parts — incoming, transforming and outgoing. Ratings, dimensions, weights and outline drawings of 16 types of Tranfo-Units are provided. I-T-E Circuit Breaker Co.

137 Low Voltage Equipment — The 84-pp Buy-Log (GEc-1100) is a condensed buying catalog of low voltage distribution equipment, including circuit breaker load centers, fuse puller panels, safety switches, wireway, molded-case circuit breakers and enclosures, panelboards, busway. It is designed so that application, selection, pricing and ordering information can be found easily. Features include selector charts for each product type, pictorial descriptions, consolidated pricing tables. Also included are ratings, weights, dimensions, standard package quantities. General Electric Co.

138 Aluminum Conductors — Current-temperature characteristics of aluminum conductors are discussed in 20-pp Section 6 of company's projected Conductor Engineering Handbook. Booklet contains graphs showing current-temperature characteristics for the most-used sizes of these conductors. Formulas are provided to facilitate calculation of characteristics for other sizes. Aluminum Co. of America.

139 Conduit and Fittings — The technical section of 60-pp Bulletin 485 includes conduit specifications and other data for use in estimating and planning electrical installations, standard symbols and abbreviations for use on drawings, and applicable electrical data. ASA specifications for the various types of conduit and electrical metallic tubing are also reproduced, and brief descriptions of typical installations included. The National Supply Co.

140 Transmission Towers — Details and specifications on a steel transmission tower designed to compete economically against conventional wood H-Frame structures are presented in this information folder. Includes test reports on transverse and longitudinal strength subjected to maximum strains. Anchor Metals, Inc.

141 Aluminum Coated Wires — Described in 6-pp Folder DH-537B is a line of aluminized steel wire and wire products, including steel core wires, steel strand guy wire, overhead ground wire, tie wire, messenger wire, telephone wire, chain link fabric and barbed wire. Properties and applications are listed. American Chain & Cable Co., Inc.

142 Electrical Connectors — Featured in 48-pp Bulletin 2711 is the ARK-trol line of electrical connectors, including plugs and receptacles in environment-resistant construction. Design and construction features are detailed and cutaway views and dimensional diagrams are included. Crouse-Hinds Co.

143 Carbon Brushes — "How to get the most out of your carbon brushes" is the subject of this 8-pp monograph. It contains detailed information on manufacture use and maintenance of carbon brushes and related types. Superior Carbon Products, Inc.

144 Capacitor Selection Guide — Six-pp Folder GED-3687 gives tables for choosing proper ratings of switched shunt capacitors for modern induction motors. Tables cover motors of all standard types, enclosures and nominal speeds, 220 to 4000 v, 2 to 500 hp. General Electric Co.

LIGHTING, COMMUNICATION

145 Architectural Floodlighting — Bulletin GER-1555 contains 8 pp of basic engineering details for use in floodlighting to enhance various types of structures. Photos show typical examples of floodlighting with charts to provide photometric data and recommended footcandle levels and distribution. General Electric Co.

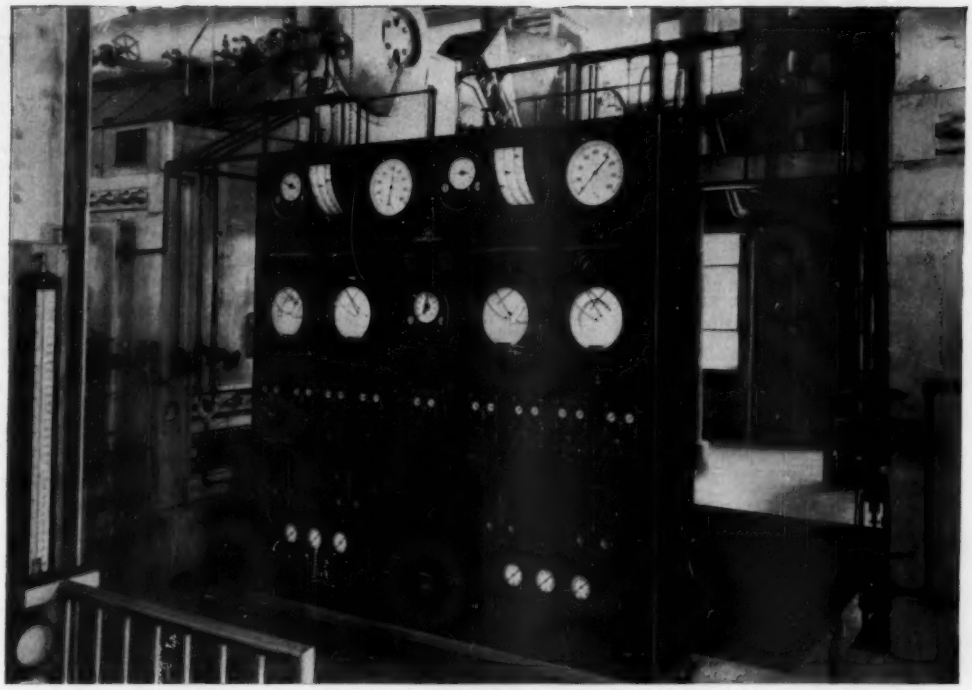
146 Transistorized Communications — Described in this product bulletin is a transistorized communications system for industrial use. Operating and equipment features are detailed and installation described. Gai-Tronics Corp.

INSTRUMENTS AND CONTROLS

147 Industrial Controls — Magnetic contactors, starters and reversing contactors, together with diagrams of enclosures and dimensions, are presented in this 12-pp bulletin. Covers starter-relay combinations, combination starters and enclosure, as well as multiple pump controls, overload heater tables and overload relays. B/W Controller Corp.

148 Pneumatic Transmitter — Bulletin Ref. No. 285.20A-1 describes a pneumatic transmitter which produces a change in output pressure proportional to a change in differential loading pressure within one-half of one per cent of full scale range. Includes photo, schematic diagram of internal parts, installations diagrams, dimensions and specifications. B-I-F Industries, Inc.

149 Flow Meter Applications — Eight-pp Bulletin MSP-160 describes many applications for company's Ring Balance meter and highlights outstanding



Bailey Meters and Controls for two boilers in a midwestern milling company.

How Bailey helps you get a new boiler off to a fast, safe start——

--The thrill of putting a new boiler "on-the-line" can be marred if you lack adequate metering and control equipment. You are a lot surer of a fast, safe start and dependable operation for a long time when you specify Bailey Meters and Controls. They are keys to peak efficiency and low operating costs.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

A131-1

Instruments and controls for power and process

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

For more data, circle 518 on Post Card

NEW NEW

TYPE T The economy cable, Type T Dekoron Multicouple Cable consists of insulated, numbered and twisted wires covered with 90% closed No. 30 cotton braid and outer sheath of .050" thick 105°C PVC. Moisture and chemically resistant; approved for direct burial. Can be installed without conduit, or with smaller conduit when necessary.

TYPE A Same construction as Type T, above, except has outer covering of modified square lock galvanized steel armor overall which shields cable, serves as conduit and provides crush resistance with great flexibility.

TYPE AT Type AT Dekoron Multicouple Cables incorporate all advantages of Types A and T. Consists of armored Type A sheathed with .050" thick 105°C PVC. Moisture, chemical, and high crush resistance. Approved for direct burial or installation without conduit in open racks.

DEKORON®

MULTICOUPLE EXTENSION WIRE

Dekoron multiple pair harness of thermocouple extension wire is available *now* in three constructions, each in either Iron-Constantan or Chrome-Alumel. All are guaranteed to *meet or exceed ISA specs* for standard grade extension wire.

And — equally important — all are designed to drastically reduce thermocouple extension wire costs. Dekoron Multicouple Extension Wire reduces installation and maintenance time . . . often cuts initial material costs . . . *always lowers installed costs.*

A-116A

Dekoron® products QUALITY • RESEARCH • SERVICE

SAMUEL MOORE & COMPANY

DEKORON PRODUCTS DIVISION • MANTUA, OHIO

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features of the versatile instrument. Discusses its use as a wide range flow meter, electronic receiver, computer for measurement of net weight of solids suspended in a fluid stream, Btu measurement in a heat exchanger, and measurement of weight flow of gas undergoing density variations, electrical flow signal transmitter, ratio controller, others. Controls Div., Hagan Chemicals & Controls, Inc.

150 Liquid Level Indicator — Bulletin WG-1824, Supplement B, describes a miniature transistorized secondary liquid level indicator. Covers construction details, advantages, weight, dimensions. Yarnall-Waring Co.

151 Gas Flow Control — Twelve-pp Form ADC 888 presents gas flow control equipment for argon, helium and carbon dioxide. Operation and applications for this equipment are described and photos of each type provided. Catalog covers manufacturer's newest additions to the line — a series of fixed-pressure regulators with flow adapters. Details on demand type proportioner for users of special gas mixtures for pipeline distribution systems are also given. Air Reduction Sales Co.

152 For Steam Service — This catalog sheet covers a differential pressure regulator for steam service, for controlling atomizing steam pressure at an adjusted value higher than fuel oil pressure; and one for controlling it at a value lower than oil pressure. Contains photos, lists of materials, and information on installation and operation of both valves. Atlas Valve Co.

153 Treatment Plant Control — Eight-pp Performance Report W18.1-2 describes control of the treatment plant for boiler feed water at a typical utility. Problems faced by the utility and its method of solving them are detailed. Bailey Meter Co.

154 Flexible Controls — Applications and advantages of Tru-Lay push-pull of flexible controls for continuous or intermittent transmission of reciprocal motion are detailed in this 16-pp bulletin. Construction features, control dimensions and control selection data included. American Chain & Cable Co., Inc.

155 Instrument Control Panels — Details of construction, dimensions, weights, instrument mounting and accessories for a standard line of instrument and control panels are presented in 16-pp Product Specification G71-7. Standard procedures for tubing and wiring are given along with convenient check list for ordering. Bailey Meter Co.

156 Packaged Control Panels — Illustrated 10-pp Bulletin 170 presents a line of packaged automatic control panels for gas-engine-driven compressors. Component features are fully described and typical installations pictured. Clark Bros. Co.

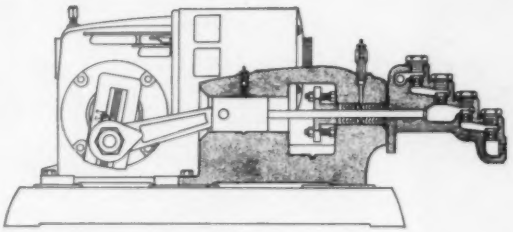
HEATING, AIR CONDITIONING

157 Electric Space Heating — This 36-pp revision of company's electric heating design guide (Booklet B-3768C) deals primarily with residential heating, but contains charts providing a simple way to compute heat losses for most installations. Only exposed floor and window area is needed to determine heating capacity required for a given room or area. The guide also tabulates some practical heat transmission coefficients and a set of formulas

HOW TO METER ACIDS ACCURATELY AGAINST PRESSURE

Corrosive liquids present two major obstacles to achieving maximum metering accuracy, economy, and safety. For one thing, corrosion can introduce an intolerable ever-changing volumetric error. For another, corrosive liquids must be retained by the pump at all times. Leakage can endanger personnel and necessitate the premature replacement of pump parts and associated equipment.

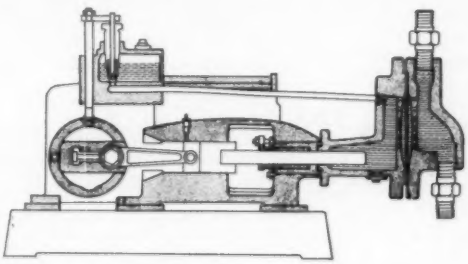
But both obstacles can be successfully overcome. First by choosing the right pump for the metering job at hand. Second, by making sure that all wetted parts of the pump chosen are inert to the liquid being metered. Here are some ideas based on practical acid metering experience that may help you to choose the one best controlled volume pump for your metering needs.



Packed Plunger Pumps

For the majority of mildly corrosive liquids, low cost packed plunger pumps have proved themselves entirely adequate. Some thirteen materials of construction are *standard* on packed plunger pumps, running from cast iron to Hastelloy B and C, more than enough to satisfy mild corrosive metering requirements. Capacities to 2056 gph, pressures up to 50,000 psi.

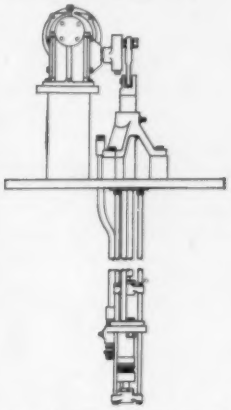
An added tip: Standard Milton Roy motor driven pumps in corrosive service can be equipped with "catch-all" yoke type gland followers.



Diaphragm Liquid Ends

When the liquid to be metered is highly corrosive or otherwise dangerous, a controlled volume pump with diaphragm liquid end is the best choice. A plastic or stainless steel diaphragm positively separates the process liquid and the plunger. The plunger displaces a hydraulic fluid which in turn strokes the diaphragm to create pumping action through the ball checks. Consistently high accuracy is achieved through unique design features. As the illustration shows, positive mechanical action bleeds any air or vapor from the hydraulic side between strokes and corrects liquid volume if necessary. Internal liquid end design also automatically eliminates bubbles from the process liquid side.

Very often, a pump chosen for mild corrosive service is obsoleted by a process change specifying a more highly corrosive liquid. But this waste is neither necessary nor desirable. The diaphragm liquid end illustrated can easily be substituted for the conventional liquid end on any standard motor driven controlled volume pump, bringing the entire metering system up to date at little extra expense. *Designs of this type will handle up to 400 gph against heads to 2700 psi.*



Totally Immersed Liquid Ends

Special metering problems demand special pump designs. For example, acids with high vapor pressure or high specific gravity must be pumped with limited suction lifts and generally require suction heads. The ideal answer is the standard Mersemetric® controlled volume pump. Pump drive and motor are mounted on the tank top, but the liquid end is completely submerged to a depth of up to fourteen feet. This same design feature also eliminates the need for tank connections below liquid level, and permits chemicals to be metered *directly* from storage.

The maximum safety-minimum handling Mersemetric design is just about standard for metering sulfuric acid for demineralizer regeneration and pH control of cooling tower water and deaerator effluents. *Capacities up to 218 gph, pressures up to 1200 psi.*

The Acid Metering *System*

You can be fairly sure of making the right choice only if you consider *all* the factors. Here's a convenient checklist of a few points that are often overlooked:

- Is the entire *system* corrosion-resistant . . . storage tank, suction and discharge piping, controlled volume pump, and relief valve?
- Have you thoroughly considered the physical properties of the liquid? High vapor pressure or high specific gravity liquids may demand a suction head.
- Have you considered plant and personnel safety under all possible conditions?
- Have you considered maintenance as well as first cost in determining the economics of the system?

If precision pumping of dangerous chemicals is one of your problems, look again to Milton Roy's 25 years of experience for your most economical solution. Write for a general introduction to controlled volume pumping in Bulletin 553-1. Milton Roy Company, 1300 East Mermaid Lane, Phila. 18, Pa.

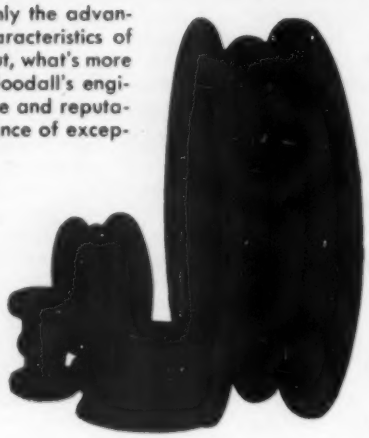
milton Roy
CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers • Chemical Feed Systems

For more data circle 520 on Post Card

Four Good Reasons For Installing GOODALL RUBBER EXPANSION JOINTS

Goodall Expansion Joints have not only the advantages stemming from the natural characteristics of rubber for all types of installations, but, what's more important, they have back of them Goodall's engineering skill, manufacturing experience and reputation for quality that give added assurance of exceptional service under all conditions.



EASIER TO INSTALL...

Goodall Rubber Expansion Joints are quickly, easily installed on new construction or as replacements. They are light in weight to facilitate handling, with short face-to-face dimensions for easier application where space is limited. Retaining rings are quickly aligned and bolted. No gaskets are required.

RESPONSIVE TO MINIMUM PRESSURE...

With Goodall Rubber Expansion Joints only the slightest pressure is required to create movement in any direction. Result—stress on metal pipe or other member is eliminated or, at most, reduced to an absolute minimum.

MANY SIZES...HIGH WORKING PRESSURES...

Goodall Rubber Expansion Joints are available in sizes from 3/8" to 96" I.D., in all required styles and constructions. Working pressures range up to 125 P.S.I. for Pressure Joints, and to 90 P.S.I. for Vacuum-Pressure Joints, depending on size.

LONGER SERVICE LIFE...

Goodall Rubber Expansion Joints last longer in service because of inherent characteristics of the material from which they are made. There is no embrittlement... continuous movement (flexing) actually keeps the rubber joint "alive". There is no corrosion or electrolysis. Resistance to abrasion is exceptionally high. Replacement costs are lower.

"If it's GOODALL, it MUST be Good"

Contact Our Nearest Branch or Write for Catalog

Standard of Quality—Since 1870

HOSE · BELTING · FOOTWEAR · CLOTHING AND OTHER INDUSTRIAL RUBBER PRODUCTS

GOODALL *Rubber Company*

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

BRANCHES AND DISTRIBUTORS THROUGHOUT THE UNITED STATES. IN CANADA: GOODALL RUBBER CO. OF CANADA LTD., TORONTO.

useful in solving any heating capacity problem. Westinghouse Electric Corp.

158 Central Air Conditioners — Featured in 76-pp Bulletin 9227 are low pressure and high pressure central station air conditioners. Discusses and illustrates design features, construction details, cooling and heating coils and accessories. Tables are included to indicate fan capacities, coil air friction, selection factors, water coil data, coil capacities and physical data. American-Standard.

BOILERS, HEAT EXCHANGERS

159 Two-Pass Boilers — Featured in Bulletin BE-100 is a line of packaged firetube type boilers with two-pass design. Illustrates and describes design and operation advantages and includes section on analysis of heat transfer in boiler tubes. Boiler Engineering & Supply Co., Inc.

160 Automatic Boilers — Eight-pp Bulletin 1250 describes mechanical pressure atomizing oil-fired and partial premixing gas-fired, packaged automatic boilers. Outstanding features are detailed and table of ratings, dimensions and weights included. Orr & Sembower, Inc.

161 Heat Exchangers — Advantages and performance characteristics of Alcotwin longitudinal finned-tube heat exchangers and thermal heaters are described in 12-pp Bulletin FH-3-R. The exchangers are designed for high heat transfer rate and fluid flow at low cost. Bulletin details company's finned-tube equipment for process applications and includes isometric cutaways and exploded views of complete units and regular and high pressure closures. Gives dimensions, mechanical specifications, physical data for steel and nonferrous heat exchangers, and finside coefficient and finside pressure drop for Alcotwin exchangers. Alco Products, Inc.

OTHER EQUIPMENT

162 Fuel Sludge Solvent — Bulletin 594 introduces Fuel-Solv, formulated to eliminate, by chemical means, many difficulties encountered in use and handling of residual fuel oils. Explains how Fuel-Solv disperses and removes sludge in tanks, suction lines, strainers etc., prevents new accumulations of sludge and improves fuel atomization and combustion. Betz Laboratories, Inc.

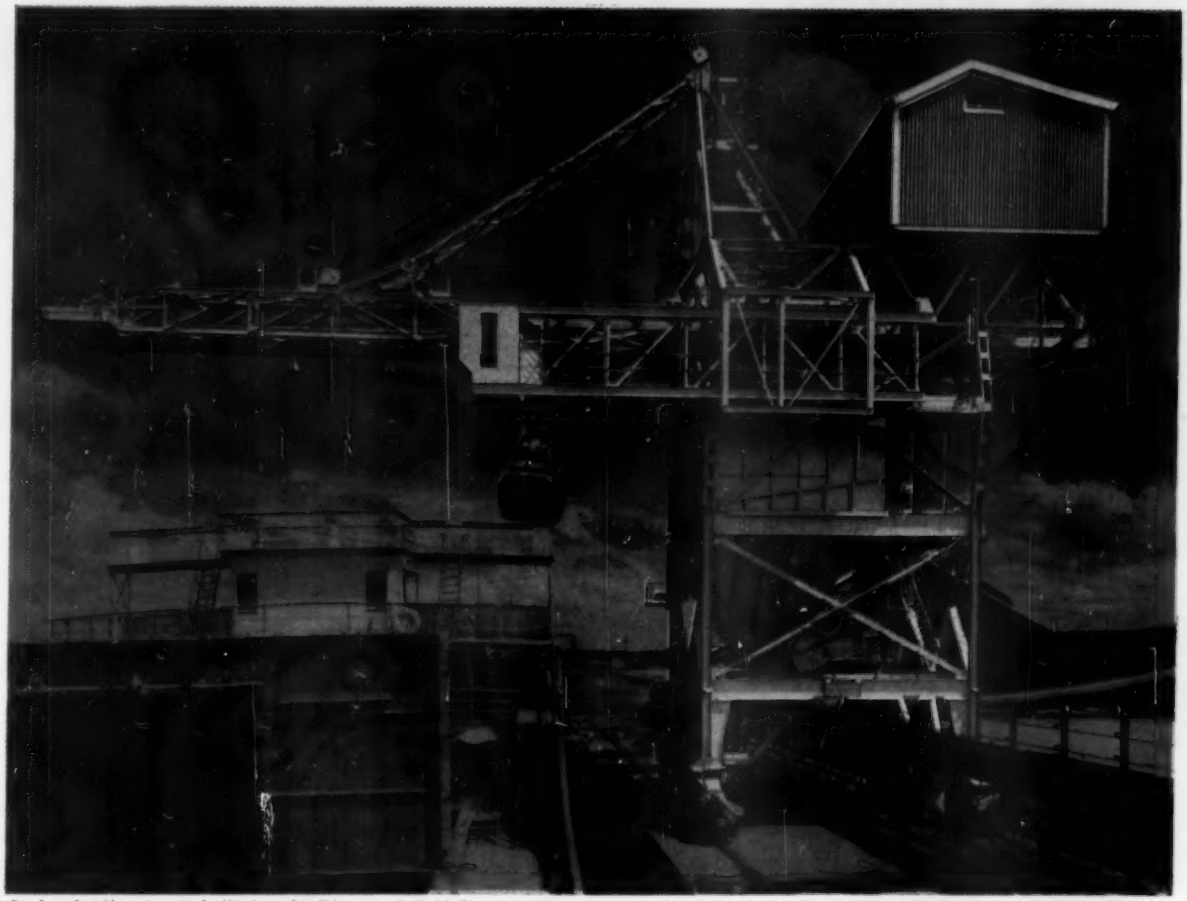
163 For Drafting Rooms — New products and improvements in established lines are presented in this 1959 general catalog GC-59, 24 pp, on drafting equipment. Introduced is the Staktube roll file, a "file and find" storage system for large rolled blueprints and drawings. Also shown are Inter-Master and Planmaster flat drawer files, Draftmaster, Stacor-Matic, Thriftmaster and Woodmaster drawing and drafting tables and equipment. Catalog is fully illustrated, and provides dimensional and ordering information. Stacor Equipment Co.

164 Coating Systems Compared — Chart No. 5 compares 17 standard maintenance coating systems showing strong and weak points of each. Accurate resistance ratings are listed for acid, alkali, solvent, water, weathering, flexibility, impact and abrasion, and temperature conditions. Compatability over old paint, surface preparation and general comments included. Carboline Co.

For more data circle 521 on Post Card

MEAD-MORRISON

UNLOADING TOWERS



Coal unloading tower built for the River and Gulf Transfer Company on the dock of the Tampa Electric Company, Tampa, Florida.

This tower incorporates the most advanced engineering refinements. A one rope progressive reeving system, hydraulic rail clamps, extendable air conditioned cab, enclosed hopper, jib crane, and dead man control all contribute to make the complete operation easier and more efficient. The patented Mead-Morrison reeving system uses one rope for both the hoisting and closing operations, increasing the rope life of the system more than 300%. The Mead-Morrison hydraulic rail clamps are provided with serrated shoes to grip the rail and do not depend on friction to hold the structure fixed to the rails. For better operator visibility when unloading ships the extendable cab is extremely advantageous. The hopper enclosure confines dust to the hopper area, greatly reducing the amount escaping to the outside.

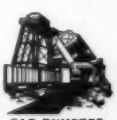
MANUFACTURING ENGINEERS • McK • ESTABLISHED 1895 •

McKIERNAN-TERRY CORPORATION

ORE BRIDGES

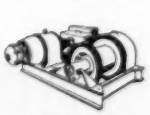
RAIL CLAMPS

PILE HAMMERS



CAR DUMPERS

GRAB BUCKETS



CAR HAULS

MEAD-MORRISON DIVISION • HARRISON, NEW JERSEY

WESTERN SALES OFFICE: 7 SOUTH DEARBORN STREET, CHICAGO 3, ILLINOIS

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ROTOJET®
Tube Cleaners

Clean tubes and pipes from ½" to 12" I.D. THOROUGHLY QUICKLY

ROTOJET Model 512 Air-driven Motor, universal joint, swing-frame head, and solid brush.

Our large stock of Rotojet air-driven and water-driven tube cleaners, accessories, and repair parts for straight and curved tubes, pipes, and transfer lines is available to meet most requirements without delay. Tube cleaner specialization for 43 years assures satisfactory results from any Rotojet equipment we recommend. Send for Bulletins J-410 and R-105. For quick action wire or phone, HUmboldt 3-0570.

ROTOJET Model C-526 Air-driven Motor with pivot head and universal joint.

ROTOJET Model C-525 Air-driven Motor with swing-frame head and universal joint.

ROTOJET Junior Model S32 Air-driven Motor, universal joint, cone cutter.

ROTOJET Junior Model C434 Air-driven Motor, flexible coupling, expanding brush.

ELLIOTT COMPANY – ROTO PLANT
Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

For more data circle 523 on Post Card

165 Galvanized Steel Sheet — This 36-pp buyer's manual on galvanized steel sheet describes the significant factors governing properties, applications, specification, purchase and maintenance of galvanized steel sheet for industrial uses. Illustrated with photos, drawings and charts, manual discusses methods for computing required quantities of galvanized sheet, and charts simplify such considerations as allowance for laps, number of formed sheets required to cover specific area, etc. American Zinc Institute, Inc.

166 Steel Cooling Towers — Bulletin 53-902 describes a line of horizontal induced draft steel cooling towers. Included are dimensional data and diagrams, as well as capacity table and specifications. J. F. Pritchard & Co.

167 Underfeed Stoker Chart — This chart is printed on heavy paper stock for display in boiler rooms. One side contains detailed instructions for operation of single-retort underfeed stokers; reverse side summarizes directions for starting fire, cleaning fire and restoring fuel bed. Bituminous Coal Institute.

168 Propeller Fans — Detailed information on company's complete line of self-cooled motor propeller fans is presented in 20-pp Catalog 159. Includes selection data, specifications, details on fan construction and dimensions. Ilg Electric Ventilating Co.

169 Packaged Deaerators — Bulletin 4528 describes packaged deaerators for small and medium sized boiler plants. Principle of operation and advantages of design are detailed, and cutaway view, and complete capacity data included. The Permutit Co.

170 Extension Wire — Featured in this product bulletin is a line of multicouple extension wire designed to reduce thermocouple-extension wire costs. Advantages are detailed and complete specifications and price information given. Samuel Moore & Co.

171 Space Filter—Performance, construction and installation details on company's space filter designed for high efficiency air filtration are presented in 8-pp Bulletin 1505-6. Typical applications are described. Mine Safety Appliances Co.

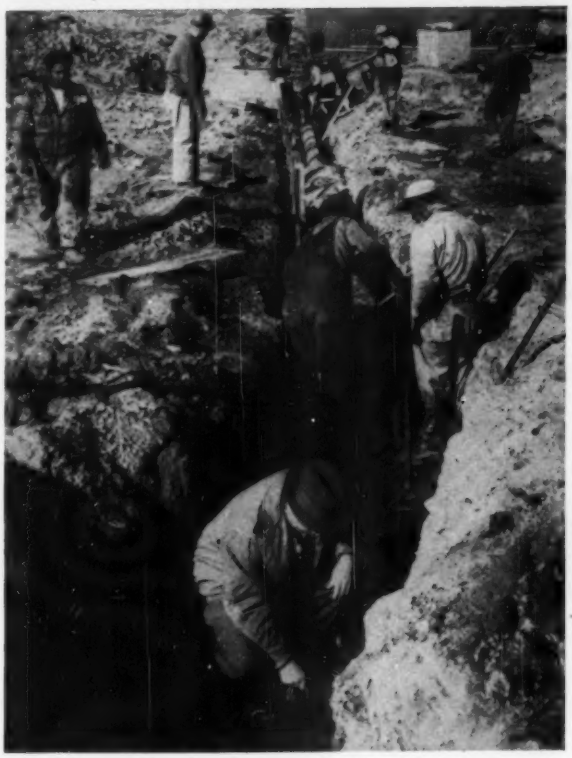
Postage-free cards for ordering bulletins are on page 113. You may also use the cards to order literature mentioned in the ads.

172 Power Units — Both Catalogs BU-528 and BU-531 tell the design, engineering and performance capabilities of two of company's engines and power units. Numerous illustrations, including a center spread devoted to cross section of the diesel units with descriptive marginal notes included. Allis-Chalmers Mfg. Co.

173 To Kill Hot Fires — Brochure P-48, on dry chemical fire extinguishers, outlines "how to use" and "recharge techniques for 2½- to 30-lb models. Accessory equipment, is also covered. Includes chart explaining classes of fires and approved portable extinguishers to be used on each. Walter Kidde & Co., Inc.

The Esso Research Center's 3-story, 600-ft.-long office building includes conference rooms, technical library, correlations and computor center, medical department, cafeteria and landscaped court for its 800 employees. The project was designed and engineered by Voorhees Walker Smith Smith and Haines of New York City. Frank Briscoe, Inc., Newark N. J., is general contractor. August Arace & Son, Inc., Elizabeth, N. J., is mechanical contractor for heating and air conditioning. Alward Construction Co., Bernardsville, N. J., is doing the insulation work.

Esso Research Center uses GILSULATE® for insulating mile of underground steam pipes

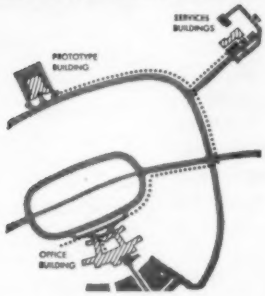


GILSULATE goes in fast. In the foreground the field inspector checks depth of pour. Directly in back of him, two workmen are shovelpointing and tamping. Other workers are sliding GILSULATE bags into pipe trench while men at rear are placing plywood forms near manhole.

Esso Research and Engineering Company, the scientific and engineering affiliate of Standard Oil Company of New Jersey, is now constructing a modern research center in Florham Park, N. J. To preserve the natural beauty of the 675-acre site, all heating, air conditioning, power and communications lines are run underground.

Steam, at a pressure of 250 lbs. (406°F.), will flow through a 600-ft.-long, 12" welded steel pipe from the boiler room to a manhole where a 1400-ft. string of 10", 8" and 6" pipe will carry heat to the prototype building. Similar piping leaves the other side of the first manhole and runs 2500 feet to the main office building. Trenches also carry 3" to 6" condensate return lines. The system has 24 expansion loops and seven manholes, and includes capped lines for use when facilities are expanded.

Over 500 tons of GILSULATE will be used for insulating and protecting the underground steam pipes. In addition to its low thermal conductivity, GILSULATE resists attack by acids, alkalies and electrical conductivity and provides excellent protection against corrosion. For full information on this low-cost, poured-in-place insulation, see your local GILSULATE distributor, or write our Salt Lake City office.



FACTS ABOUT GILSULATE

1. **EASY TO USE**—just pour, shovelpoint and tamp...pipe heat does the rest.
2. **FORMS 3 ZONES** of protection against heat loss and all hazards commonly encountered by buried hot pipes.
3. **NEEDS NO HOUSING OR MECHANICAL SHEATHS:** no mixing, special handling or equipment.
4. **ONLY NEEDS NORMAL PIPE SPACING:** for multiple pipe or cramped conditions.
5. **THREE TYPES AVAILABLE:**
   Type A for 220-300° F. temp. range
   Type B for 300-385° F. temp. range
   Type C for 385-520° F. temp. range

THE TRIPLE-ZONE INSULATION FOR LIFETIME PROTECTION OF UNDERGROUND HOT PIPES

GILSULATE®

AMERICAN GILSONITE COMPANY

Affiliate of Barber Oil Corp. & Standard Oil Co. of California
Offices at: Municipal Airport P.O. Box 15, Salt Lake City, Utah
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HELPFUL WATER CONDITIONING DATA FROM BETZ

BOILER FEEDLINE DEPOSITS

This helpful discussion outlines the factors affecting deposit formation in the preboiler system and suggests corrective measures.

THE formation of deposits within the boiler feedline is always troublesome, and frequently can prove dangerous if deposits develop to the extent that they prevent an adequate supply of boiler feedwater from reaching the boilers. Serious damage can occur to boilers due to low water with the consequent warping, blistering or failure of the tubes, and bulging of the tube sheets or shell.

Where feedline deposits have not developed to the point that they constitute a definite operating hazard, they may interfere with the heat transfer in closed heaters or economizers and cause considerable loss in thermal efficiency. Further, in order to overcome the friction loss caused by the deposits, increased boiler feed pump pressure is required. Feedline deposits usually interfere with the normal operation of automatic feedwater regulators causing abnormal changes in boiler water level, resulting in possible carryover of boiler water solids in the steam, or low water damage.

Hardness in the feedwater causes scale deposits to form on boiler heat exchange surfaces. In a similar fashion, hardness can also deposit scale in boiler feedwater lines. This problem is not unusual in boiler feedwater systems using the effluent from hot or cold lime soda or hot phosphate softeners. After-precipitation in the effluent from filters following the lime soda units, and less than top efficiency in filter operation after hot phosphate units, frequently result in feedline deposits. Serious corrosion in condensate return systems contributes to or may be entirely responsible for the same difficulty.

Calcium carbonate and calcium phosphate are the most common constituents of deposits in boiler feedlines. Iron oxides may also be present and occasionally under unusual conditions, deposits of calcium silicate, magnesium silicate and organic compounds of calcium and iron may contribute to the total deposit. Feedline deposits may also arise from mechanical conditions which permit silt, bits of cloth, gasket material, filter medium and other debris to enter the boiler feedwater system.

Calcium Carbonate Deposits

Deposition of calcium carbonate in the boiler feedline will result when the pH of saturation of calcium carbonate is exceeded.

The effluent from lime soda softener units, operating either in the hot or cold, is saturated with respect to calcium carbonate at the temperature of the softening operation. Since the solubility of calcium carbonate decreases with an increase in temperature, calcium carbonate will be precipitated from solution and deposited as scale in closed heaters and economizers when the feedwater temperature increases through these units.

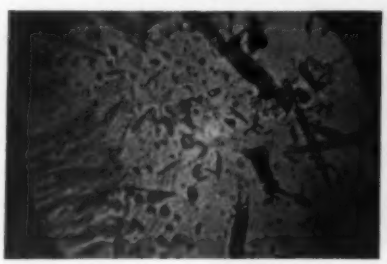

Figure 1—Calcium carbonate scale crystals at 450 magnifications

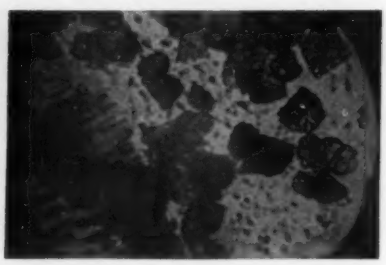

Figure 2—Distortion of crystals by feed of an organic surface active agent

The tendency for precipitation of calcium carbonate is reduced when the softened water, after filtration, is diluted with condensate. The condensate should be added to the softened water after filtration. If introduced prior to the filters, it will merely redissolve the suspended calcium carbonate and may not relieve the condition of calcium carbonate saturation in the filter effluent.

Raw water, high in hardness due primarily to soluble bicarbonates, frequently causes feedline deposits when used for boiler feedwater makeup. For every temperature, an equilibrium condition exists between the free carbon dioxide content of the water and the amount of calcium bicarbonate that can be held in solution. Even the slightest temperature increase may be enough to offset equilibrium and result in precipitation of calcium carbonate deposits.

Soda ash and caustic soda are frequently used to establish and maintain proper boiler water alkalinity and pH. When fed continuously to the boiler feedline, equilibrium is upset since both soda ash and caustic soda tend to increase the alkalinity and pH of the feedwater. Where a closed heater or an economizer is in use, the continuous feed of alkaline materials to the boiler feedlines will cause calcium carbonate deposits, except where the hardness of the feedwater is low as in the case of an effluent from a properly operated zeolite softener.

Any method which will lower the pH of saturation will reduce the possibility of feedline deposits. Recarbonation, continuous controlled feed of acid, and use of inorganic and/or organic surface active agents are methods commonly used to control this problem.

The continuous and proportional feed of acid to a lime soda softened makeup water relieves the oversaturated condition with respect to calcium carbonate and will prevent deposition in the boiler feedwater systems. However, careful control of acid feed is required, and proper feeding equipment is necessary to avoid the obvious hazards of acid treatment.

A much less hazardous and more commonly used method for the prevention of feedline deposits is the use of surface active agents. Relatively small concentrations of surface active agents, usually not more than 10 ppm, will serve to retain calcium carbonate in solution even where an oversaturated condition exists.

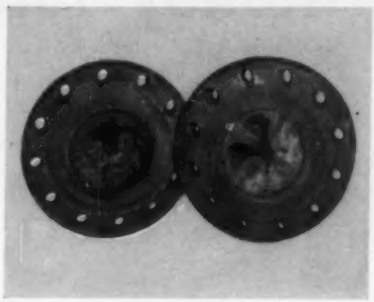

Figure 3—Sections of 8-inch diameter feedline showing calcium phosphate deposits

The use of surface active agents to prevent deposition is dependent on the power of the surface active agent to inhibit precipitation of calcium carbonate. The crystal distortion produced by organic agents is a large factor in retarding precipitation of calcium carbonate. Figure 1 shows, at 450 magnifications, calcium carbonate crystals formed at a heat transfer rate of 17,000 Btu per sq. ft. per hour. Figure 2 illustrates the distortion of the crystal formed under the same conditions in the presence of an organic surface active agent.

Calcium Phosphate Deposits

Deposits of calcium phosphate are frequently encountered in boiler feedwater lines. These deposits may result from several sources. Where the feedwater supply is the effluent from a hot phosphate softener, any increase in temperature after the softener will result in further precipitation of calcium phosphate in the feedline. Calcium phosphate also may be precipitated in the feedline where a phosphate base boiler water treatment is fed continuously, or in some cases even with shot feed through the boiler feedline.

When the phosphate so fed is in the ortho form, the probability of calcium phosphate deposit increases. Even with the use of a polyphosphate, some reversion may take place and deposits develop. Thus, depending upon calcium hardness, temperature and retention time, serious difficulties may arise when phosphates are fed through the boiler feedline. Introducing the phosphate only a few feet outside the boiler drum does not prevent deposition of an undesirable magnitude over a period of time. The speed of deposit formation is dependent on feedwater calcium hardness. If zeolite softening is used or if the makeup water is of a naturally low hardness, the speed of deposit formation is greatly reduced or prevented entirely.

The best method of introducing phosphate to the boiler water is by feeding continuously directly to the boiler drum employing a small chemical pump. If it is not possible to feed by this method, it becomes necessary to resort to shot feed or to feed intermittently to the boiler feedline. A by-pass shot feeder or a timer controlled high capacity chemical feed pump can be employed.

Iron Oxide Deposits

Iron oxides also contribute to or may be entirely responsible for feedline deposits. Iron present in well supplies used for boiler feedwater makeup will be precipitated by the increase in temperature that takes place in the deaerating feedwater heater. The increase in pH value of the feedwater as it passes through the heater (caused by the expulsion of the free carbon dioxide and breakdown of the bicarbonate alkalinity of the feedwater to produce carbonate alkalinity) will precipitate the iron from solution as finely divided ferric hydroxide. Intermittent boiler operation where the boilers are out of service overnight or over weekends causes a more rapid build-up of this precipitated material in the feedline. Iron may be present in the feedline deposits as a result of corrosion of the line at the point of deposit formation. The deposit may also be present as a result of corrosion in steam and return lines.

Iron may be removed from raw water by means of several different methods or combination of methods. Oxidation by aeration or chemical reaction followed by coagulation, sedimentation and filtration will produce an effluent water satisfactorily low in iron content. The external treatment of the raw makeup water to reduce hardness and alkalinity will also reduce the iron content. After-treatment of the steam to prevent carbon dioxide attack has been highly successful in reducing return line corrosion. Filming amines and neutralizing amines are most widely used as after-treatments in controlling this problem. Filming amines which function by establishing a nonwettable film on the metal surface in the condensate system, will protect the return system from both carbon dioxide and oxygen attack. Neutralizing amines react directly with carbon dioxide produced in the steam and are effective only against carbon dioxide attack.

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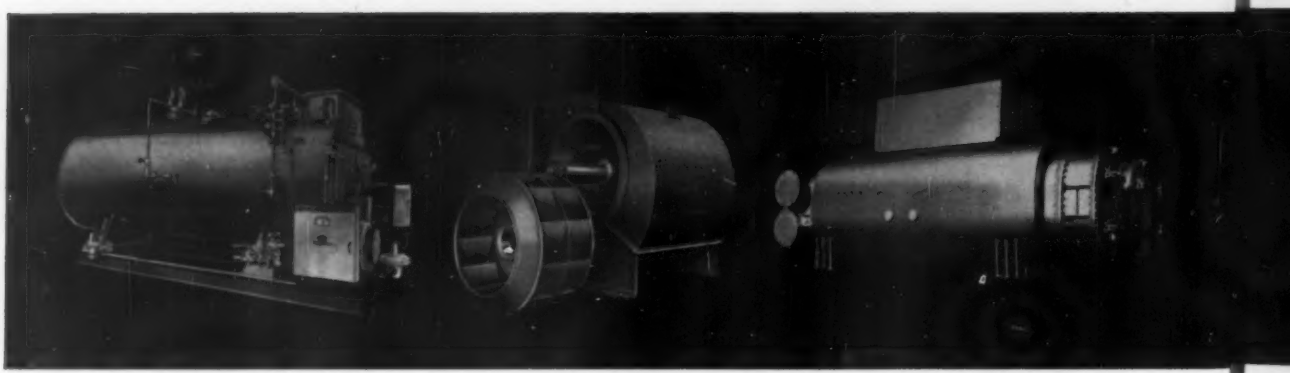

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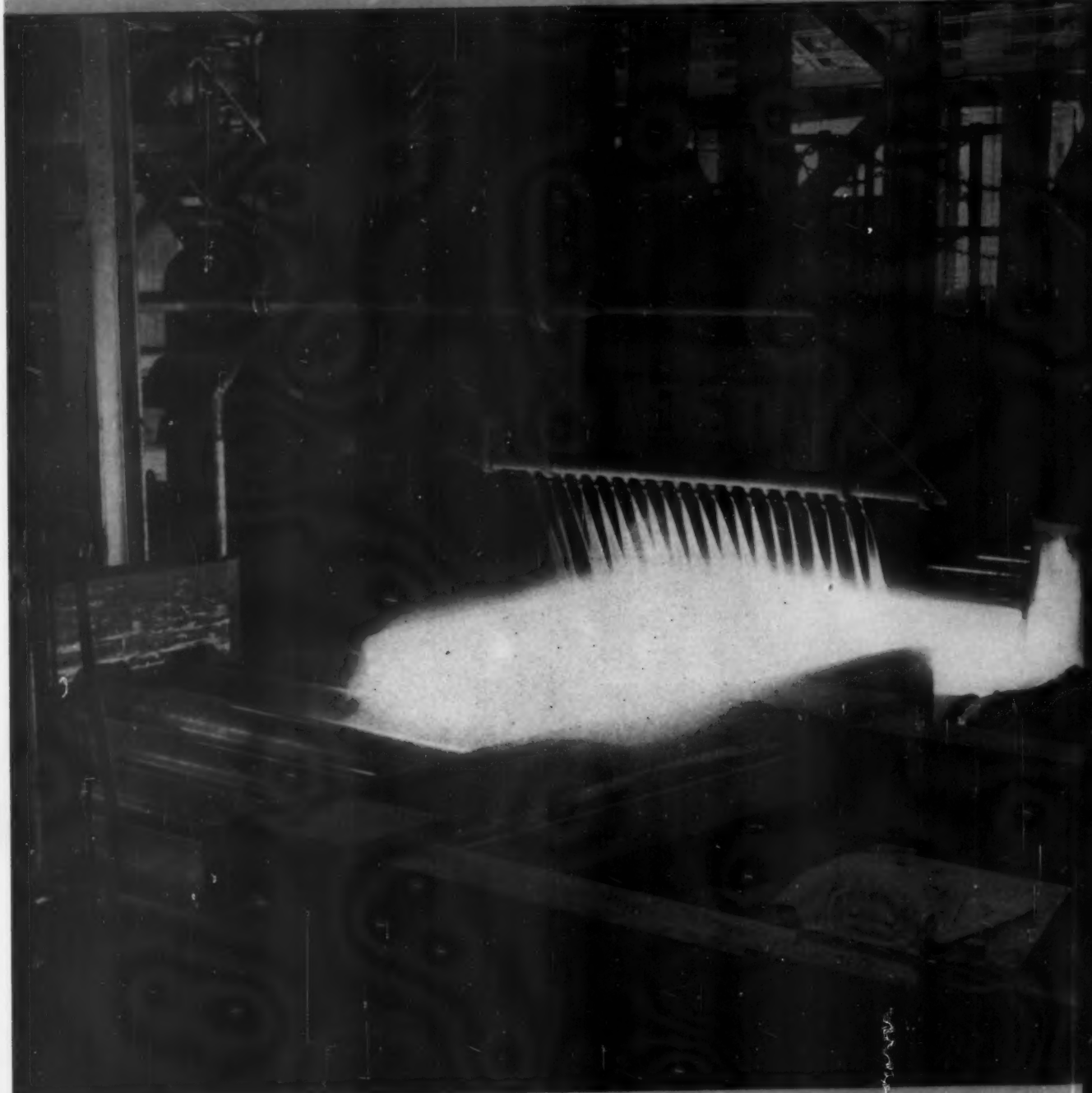

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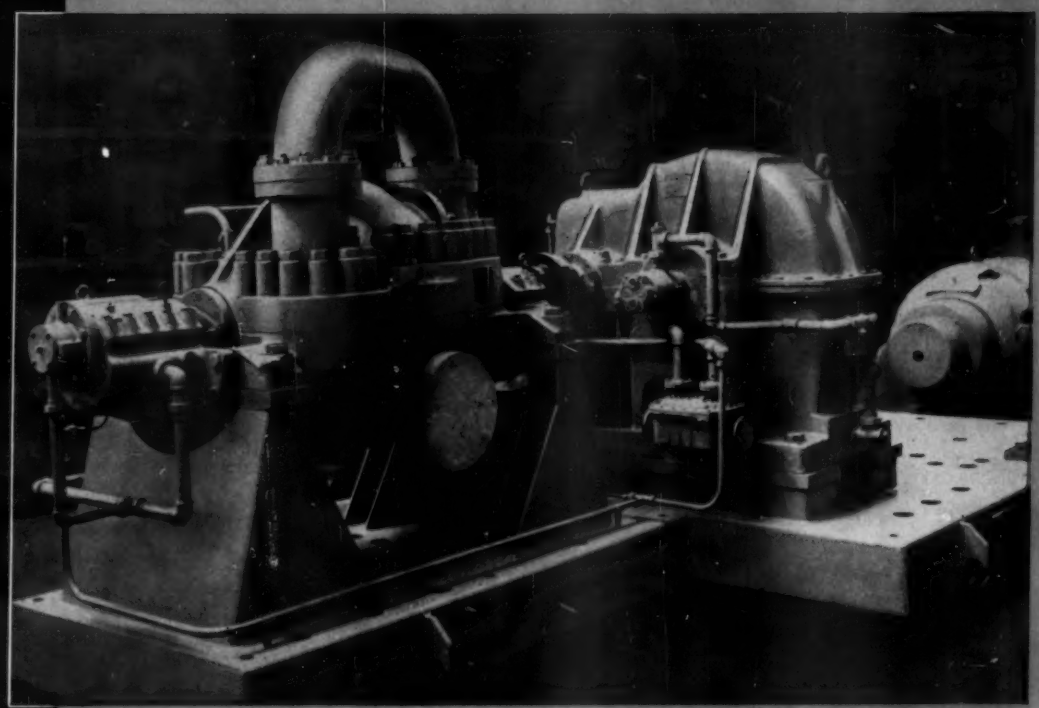
Latest successful technique of high-pressure descaling is now being performed in this modern steelmaking facility designed by Mesta Machine Co.

The initial high-pressure descaling operation uses De Laval split-case multi-stage pumps as shown in the photograph below. Each pump supplies cold water at 1000 gpm and 1600 psig. Electric motors rated at 1750 hp drive the pumps through speed increasers which raise the speed from 1200 rpm to 4250 rpm.

De Laval pumps also serve Lukens on a 1200 psig descaling system in another section of the Coatesville, Pa. mill.



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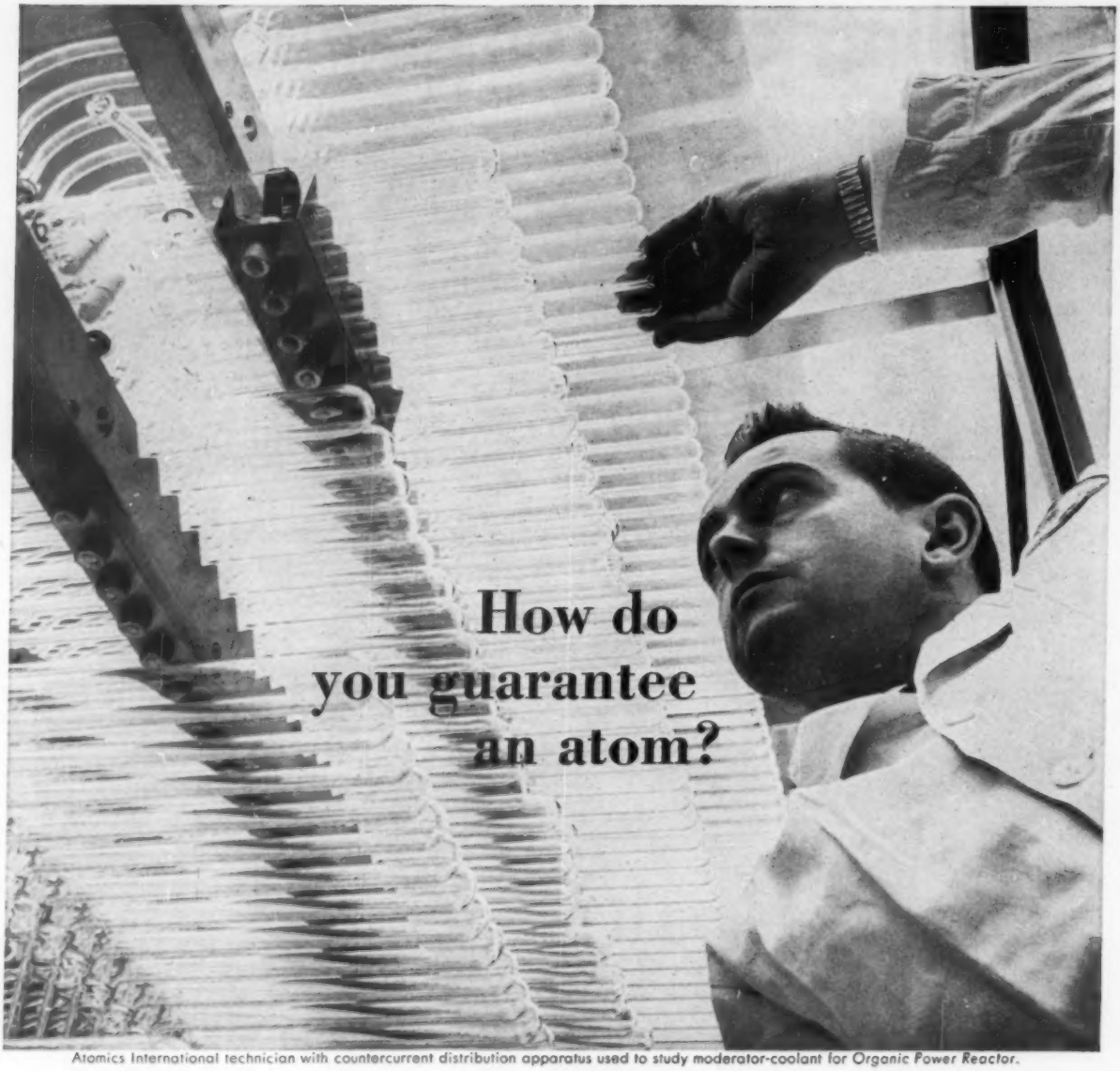

Atomics International technician with countercurrent distribution apparatus used to study moderator-coolant for Organic Power Reactor.

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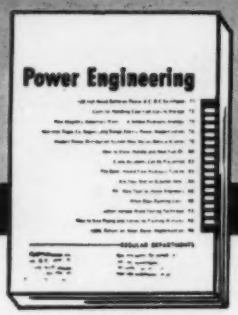

ATOMICS

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A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

July 1959

Nuclear Reactors vs Steam boilers. A nuclear power reactor is often likened to a steam boiler. In a nuclear power plant the reactor is primarily a source of heat; it takes the place of the conventional coal, oil, or gas-fired furnace and boiler. The remainder of the power system — the turbines, electric generators and auxiliary machinery — all remain essentially the same.

A nuclear reactor, however, is quite different from a furnace. The amount of energy contained in the fuel in the furnace of a conventional boiler is extremely small — no more than can carry the load for a very short period of time, a few seconds or a few minutes, depending upon the type of firing system used. A conventional furnace has to be fed continuously. A nuclear reactor, on the other hand, carries enough energy in the fuel constituting the core to operate a large power plant for many months, or even years on end, without replenishment. As an example, the initial core for the reactor for the first nuclear-powered merchant vessel, the N/S Savannah, will be able to operate the 22,000-hp ship under normal conditions for at least three and one-half years before it needs replacement.

The concentration of energy in the core of a power reactor is almost beyond belief — it staggers the imagination. Consider the fact that a quarter of a cubic inch of uranium-235 — a piece the size of a small eraser — contains as much energy as 5000 cu ft of coal.

It is this enormous quantity of stored energy in the fuel elements of a nuclear reactor which makes a reactor completely different from an ordinary steam boiler installation. While it is impossible for a nuclear reactor to explode in the way that an atomic bomb explodes, the energy rise in a reactor can be so rapid as to melt, or even vaporize, the entire core and surrounding structure. In such an event, dangerous radioactive fission products would be released to the environment, thereby making large areas uninhabitable for an extended period of time. Because this danger has been recognized from the beginning, the entire aim of nuclear reactor designers has been to design reactors with such safety features as to make nuclear accidents virtually impossible.

Nuclear Instrumentation. It is this aspect of reactor operation that makes the control and instrumentation completely different from the control and instrumentation of a conventional boiler and furnace. A boiler furnace is controlled by varying the fuel feed and the amount of air for combustion, i.e., the draft. This can be done automatically in accordance with the steam demand.

In a nuclear reactor of the heterogeneous type, the fuel cannot be varied; the amount in the core remains fixed. The power level in a reactor is a function of the number of neutrons — the neutron flux. This in turn is a function of the position of the control rods, and in some types of reactors, the density of the moderator. In a water-cooled and moderated reactor, for example, the

density of the water has a controlling influence on the neutron flux and, therefore, on the reactivity of the reactor.

So, in a nuclear power reactor it is essential that every means be provided to monitor and control the neutron flux between close limits. This can be done manually, but means should be provided so that if the manual control is in error, automatic control comes into action.

The neutron flux in a reactor varies enormously between the cold or shutdown condition and full power operation. When a reactor is started (initially), the neutron population is extremely low and it takes the most sensitive instruments to detect it. At full power, however, it may be a million or even ten million times as great, and then less sensitive instruments are needed. So there is no single instrument that will measure and indicate the full range of neutron activity in a nuclear reactor. Instead, a series of instrument chains are provided, one chain coming into play where another leaves off. Such an instrument chain is shown in Fig. 1, which actually gives the range of nuclear instrumentation of the Experimental Boiling Water Reactor (EBWR) at Argonne National Laboratory. It will be noted that in this case the neutron flux varies from 2 neutrons per sq cm per sec to 2 x 10^{10} n/cm²/sec — a range of ten billion!

In this diagram counters Nos. 1 and 2 are capable of measuring neutron flux from 2 to 2000 neutrons per sq cm per sec. Then the electrometer takes over, and this has a range up to 200 million neutrons per sq cm per sec.

Ionization Chambers. The most important instrument in nuclear reactor control is the neutron-sensitive ionization chamber. Ordinary ionization chambers — those not sensitive to neutrons — are very simple instruments. They were used by Madame Curie and by Rutherford as early as 1898 and 1900 in some of the earliest studies of radioactivity. A typical chamber is shown in Fig. 2. It consists of a cylindrical chamber, the walls of which serve as one electrode, and a thin metal rod as the other electrode. The nature of the gas in the chamber depends on the particular purpose intended for the instrument; it may be air, CO_2, argon, among others. The potential across the electrodes is adjusted so that normally the gas does not conduct electricity.

Suppose, now, that a single alpha particle or beta particle, or in fact, any ionizing radiation enters the tube. This will cause ion-pairs to be produced and the applied voltage will cause the positive ions to travel toward the negative electrode, while the negative ions will be attracted toward the positive electrode. As a result, charges will collect on the electrodes and an instrument will indicate a pulse of current. The amount of charge collecting on the electrodes is, of course, extremely small and the pulse must be amplified by means of an electronic amplifier before it can be indicated on a meter.

Neutron-sensitive Ion Chambers. The type of ion chamber just described, will not respond to neutron radiation, however. In order to measure neutron flux it is

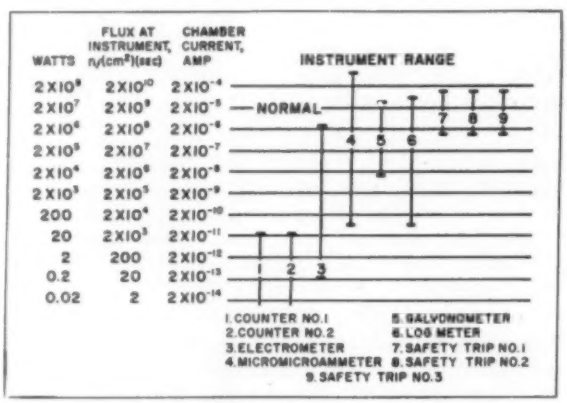

Fig. 1

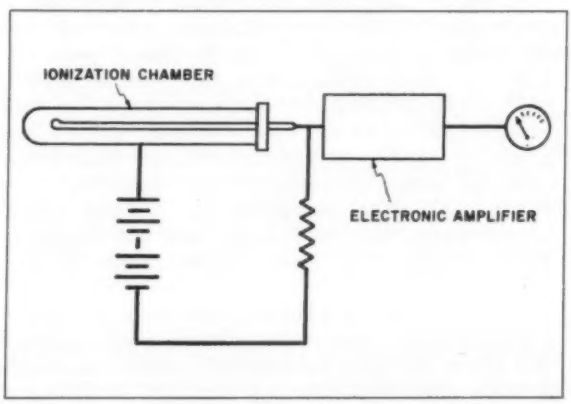

Fig. 2

necessary to make use of charged particles produced by the interaction of neutrons, that is, neutrons can be made to produce alpha particles from other elements. The most common instruments for the detection of slow neutrons in a reactor utilize the reactions of neutrons with an isotope of boron -- boron-10. The reaction involved is this:

$$_5B^{10} + {}_0n^1 \longrightarrow {}_3Li^7 + {}_2He^4 + 2.5 \text{ Mev}$$

Thus, the absorption of a neutron by the nucleus of boron-10 results in a lithium-7 nucleus and an alpha particle (helium nucleus), with the release of 2.5 Mev of energy. This energy is carried off as the kinetic energy of the lithium nucleus and the alpha particle, and this produces considerable ionization in their tracks.

To take advantage of this process in reactor instrumentation, an ion chamber containing boron-10 is used. Such chambers are similar to the simple chamber already described although they have somewhat different dimensions, and they are usually filled with boron trifluoride gas.

One advantage of this type of ion chamber is that it discriminates against other types of radiation, such as gamma radiation. When a reactor is started initially, that is, before it has ever been operated at any power level, it is desirable, of course, that the detecting instruments measure all types of radiation. However, as the reactor is brought up to power, it is important to count only the neutrons. In this type of counter, the neutron-alpha reaction in B^{10} produces 4×10^{-4} volt pulses in a normal circuit. Gamma radiation, on the other hand, produces pulses of 10^{-6} volts for similar conditions. Thus, a factor of 400 is available for discrimination against gamma radiation. Counters of the boron-fluoride variety have efficiencies of about 10 per cent, that is, they give 10 counts for every 100 neutrons entering the chamber.

For measuring neutron flux at higher levels somewhat different types of detectors are used. The useful range of the ion chambers described is usually exceeded as soon as the reactor becomes critical or supercritical. Beyond that range neutron ion-current chambers are used. The principle involved in these ion-current chambers is not essentially different from the ion counters, but the construction is quite different. They are larger and usually consist of multiple plates, somewhat similar to the plates in a fixed air dielectric capacitor. Alternate plates carry opposite charges. In some cases the chambers are filled with $B^{10}F_3$ (boron trifluoride) gas, whereas in other types the boron-10 is coated on the plates. Chambers of this type can be connected directly to a meter movement relay with a 20×10^{-6} amp full-scale range and thus, form a reliable trip circuit element, but in practice they are used with a variety of instrument chains.

Other types of neutron detectors are available; for example, fission pulse chambers in which the ionizing effect of the fission products resulting from the fission of uranium is utilized. These chambers have surfaces coated with enriched uranium.

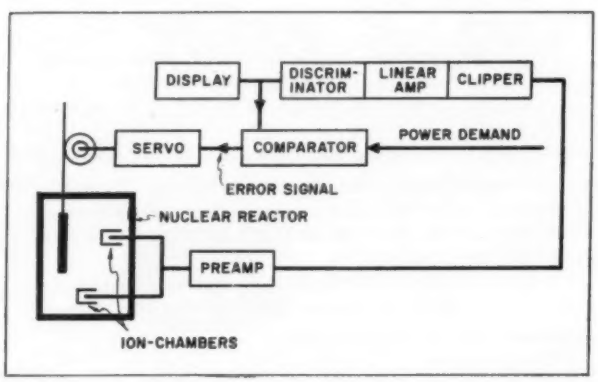

Fig. 3

A simple schematic reactor control system is shown in Fig. 3. This shows two neutron detectors connected in parallel and supplying the input to a pre-amplifier. The pre-amplifier is usually installed very close to the reactor so as to keep the length of the leads between the detector and the pre-amplifier to within 12 or 14 ft. The pre-amplifier is connected to the instruments in the control room by co-axial cable. In the control room the pulse signal is clipped (the pulse has a long tail which is cut off, thus permitting higher counting rates), then amplified and passed through

a discriminator and sent to the display, which may be audible, visual or both. The output of the amplifying system is also fed to a comparator where the neutron level is compared with desired power level. This produces an error signal which causes the servo motor to move the control rod in the proper direction.

The control system, therefore, effects the following transformations: (A) The reactor transforms a reactivity factor, determined by the control rod position, into a neutron density or power level value. (B) The neutron detector together with the amplifiers transform this neutron density into an electrical potential. (C) The comparator combines this potential with the power demand signal to produce an error signal, which may be either positive or negative. (D) Finally, the servo mechanism transforms the error signal into the desired new position of the control rod.

A closed loop of this type is not unlike a similar closed loop used in the control of conventional coal, oil, or gas-fired boilers. In the latter case, the control is effected by varying the fuel feed or the combustion air supply or both. In the case of the reactor, nothing can be done about the fuel — it is already in the reactor. It is, however, possible to vary the neutron flux by absorbing more or less neutrons in the control rods. This is comparable to some extent to increasing or decreasing the combustion air to a furnace. In the operation of a reactor it is the neutron atmosphere that determines the power level.

The great difference between the operation of a reactor and a boiler furnace lies in the speed of the nuclear reaction. The fission of uranium is a virtually instantaneous process, and the power level of a nuclear reactor can rise from zero to many millions of kilowatts in a small fraction of a second. One may wonder, therefore, why it is possible, by means of mechanical control rods, to keep a power reactor under control. It might be thought that the neutron density and the energy output would increase with such extreme rapidity that no mechanical control, even if automatic, could be sufficiently rapid.

If nature had not been considerate in this respect, it would have been extremely difficult, if not impossible, to control reactors. The reason lies in the mechanism of delayed neutrons — in the fact that in the process of fission not all of the extra neutrons (about 2.5 per fission for U-235) are emitted at the instant of fission. While over 99 per cent of the neutrons are emitted instantaneously, a very small number, about 0.75 per cent, are delayed over a period of several minutes. It is the emission of these delayed neutrons that makes it possible to control nuclear reactions, since the delay gives the mechanical control rods time to work. Usually, the temperature and coolant flow changes in a power reactor are so heavily damped in comparison to the nuclear power that there is little virtue in extremely high-speed operation of the normal control rods. Increase in rod speed adds nothing to the turbine response. It is, however, desirable and necessary to have the safety (scram) rods operate as rapidly as possible.

Andrew C. Kramer

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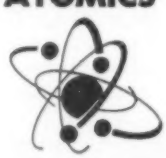

Reprints of the ATOMICS sections from POWER ENGINEERING for the six months from January to June 1959 will be available about the middle of July 1959. Only enough of these will be printed, however, to take care of advance orders. They will be available at $1.00 per copy. If you want one of these reprints, please fill in the following form and send it to

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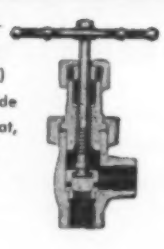
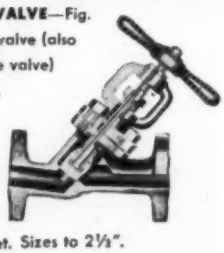
EDWARD FIG. 848 GLOBE VALVE ILLUSTRATES VALVE SELECTION PRINCIPLES

1 ANGLE VALVE—Fig. 2699, 600 lb at 900F (2000 lb WOG) with union bonnet, inside screw, replaceable seat, knobbed handwheel, and screwed ends. Sizes ¼" to 1".



2 UNIVALVE®—Fig. 2224, 1500 lb. at 1050 F (3600 lb WOG) or 2500 lb at 1050 F (6000 lb WOG) with outside screw, Impactor® handle seal-welded bonnet, integral seat and socket welding ends. Sizes to 2½".

3 BLOW-OFF VALVE—Fig. 641, straightway valve (also available as angle valve) 300 lb at 850 F, 600 lb at 850 F, 1500 lb at 850 F, with integral Stellite seat, flanged ends, bolted bonnet. Sizes to 2½".



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VALVE CONSTRUCTION DETAILS
(See large illustration, opposite page)

Valve Handwheel or Handle should be large enough to operate valve easily. Wheel spokes help keep handwheel cool. Knobbed design permits tight grip even with greasy gloves. Impact type handle will be helpful in obtaining tight closure for valves 1½ to 2½ in.

Yoke Bushing material should be checked. High-strength aluminum bronzes are usually best. Look for ample thread engagement between bushing and yoke and between bushing and stem.

Gland-Stuffing Box—Stuffing box with bolted gland assures good packing compression; hinged bolts swing out of the way but don't get lost. Be sure to get stainless steel bolts for maximum resistance to rusting, and for easy adjustment even after years of service. Packing chamber should be deep and not excessively wide.

Bonnet Joint of bolted construction is easiest to work with. You can disassemble and reassemble with pocket-size tools. Union bonnet is compact and usually less expensive for smaller valve sizes, but is not recommended for high temperatures. Bonnet gasket of soft iron performs well in most services but spiral wound metallic-asbestos gaskets are superior in high temperature services. For extreme pressure-temperature services welded bonnet joints for permanent tightness are desirable. Seal-welded type bonnet has advantage over fully welded design because it permits disassembly and reassembly.

Seat-Disk Joint—An integral hard-faced seat is generally regarded as superior to screwed seat construction because it eliminates body-seat leakage and retains hardness under temperature. A hard faced disk or disk of special alloy is desirable in high temperature services; but 13 per cent chromium stainless steel is an excellent all purpose material below 750 F.

Other Features to Evaluate—Valve compactness is important because you frequently find small piping located in crowded quarters. Inclined bonnet globe valves are less likely to erode due to high velocities—have less pressure loss. Valves of "inside screw" design (stem threads below packing chamber) are usually lower priced and give good service where temperature is not too high and where line fluids are free of sediment. But, best design and materials are useless without experienced workmanship and rigid quality control.

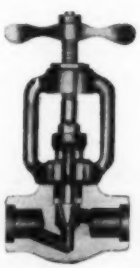
VALVE APPLICATION SUGGESTIONS

First, determine whether a standard valve will do the job before ordering expensive special designs. (Your Edward Representative can help you decide.) Often a slight modification of a standard valve, or a combination of standard valves, will do the job. Here are some facts about types of standard valves and their application:

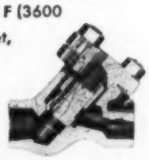
- For many services, angle valves (illustrated by valve #1) reduce installation cost, minimize pressure drop, improve operational convenience. All Edward forged steel stop and stop-check valves from ¼" to 2½" sizes are available in the angle version.
- For high temperature, Edward forged steel valves with seal-welded bonnets (#2) permanently maintain pressure tightness without periodic tightening of bonnet joints.
- For blow-off service, or wherever double valving is required, select sets of valves of the same basic type with hard-faced seating surface for dependability, longer life and interchangeability of parts (#3).
- For permanent tightness, select an instrument valve (#4) with corrosion-erosion resistant hard-faced seat or a valve with stainless steel body. Bonnetless design requires less maintenance.
- Piston-type check valve (#5), available with union, bolted, or seal-welded cover, is best for most services because it will seat tighter, has easily repairable seat face.
- Modern globe and angle stop valves (shown here) are more dependable than gate valves where repeated drop-tight closures are required, may be used for approximate flow regulation and moderate throttling.

YOUR EDWARD REPRESENTATIVE will be glad to give you the complete story on these features, plus the many other advantages of Edward valves—such as positive, pressure-tight backseats, self-centering disks, special stem and packing materials, and many others. Edward builds a complete line of cast and forged steel valves for pressures to 10,000 lbs. For additional information write to Edward Valves, Inc., 1202 W. 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W., Montreal 1, Quebec.

4 INSTRUMENT VALVE—Fig. 952Y, 600 lb or 2500 lb at 850 F (6000 lb WOG) with swing bolted gland, socket welding ends, no bonnet joint. Sizes ¼" to 1".



5 CHECK VALVE—Fig. 5538, piston type, 1500 lb at 1050 F (3600 lb WOG) bolted bonnet, screwed ends, integral Stellite seat. Sizes ¼" to 2".



*T. M. Reg. U. S. Pat. Off.

EDWARD STEEL VALVES
another fine product by
ROCKWELL

Catalog 14 contains full data on the complete Edward line of forged and cast steel valves from ¼" to 18", in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 10,000 lbs: with pressure-seal, bolted, union or welded bonnets, with screwed, welding or flanged ends.

For more data circle 530 on Post Card

HAGAN NEWSLETTER
Behind the Panel

MIDWEST UTILITY GETS POWRMAG COMBUSTION CONTROL SYSTEM

Another Hagan electronic solid state combustion control system has been contracted for by a Midwest utility for a new unit to be completed in 1961. A single furnace, single drum boiler, it will operate at 2200 psi and 1010 FTT, and have a maximum continuous capacity of 2,310,000 lb/hr steam. The Hagan systems will control combustion, fuel flow, air flow, furnace draft and pulverizer temperature and suction. Hagan's PowrMag (magnetic amplifier) components will be used for most control functions and the entire system will be solid state. Main reasons for the selection of the Hagan systems were low maintenance requirements, high accuracy and stability, and Hagan's experience. (Item H-1)

HAGAN METER AUTOMATICALLY COMPUTES "BLAST UNITS" TO BLAST FURNACES

At a leading steel company, air delivered to blast furnaces is charged to the Blast Furnace Department in terms of "blast units." A blast unit is a measure of work required to compress the air by turbo-blowers and is equivalent to 1000 kwh of electrical energy, or approximately 3,415 Btu. Blast units are calculated in terms of standard cfm air flow corrected to 15 psi gage. A common method is to integrate total air flow from air flow charts by the use of a planimeter and correlate with the pressure chart to 15 psi gage by applying certain correction factors. This method is laborious and subject to error.

However, since the installation of the Hagan Blast Unit Meter at an Eastern plant of this steel company, blast units are obtained automatically and precisely. Pneumatic signals, proportional to standard cfm and blower discharge pressure, are transmitted to the blast unit meter. The computing mechanism within the meter integrates and records blast units. Operating personnel now have an accurate and continuous record, eliminating compromise figures and manual checking. (Item H-2)

HAGAN POWRLOG TEMPERATURE CONTROLS FOR GLASS FURNACES

Fed with raw materials of special quality for the production of glass cloth, these furnaces must maintain extremely accurate temperatures in each of three sections. Initial melting is performed in the melter, maintained at 2800F. From there the glass flows to the refiner (2200F), and then to the forehearth (2200F), where the bushings through which the fiber is drawn are located. Hagan PowrLog units, with a suppressed range of 1600F to 3000F, take indications from Type R thermocouples and maintain required temperatures within 5F. Eight furnaces are under Hagan control as well as eight recuperators. Trouble-free operation, minimum maintenance and quick delivery were some of the factors which influenced the choice of Hagan as the supplier for these systems. Where even closer control is required, it is interesting to note that Hagan PowrAmp temperature controllers, sensitive to thermocouple fluctuations of one-millionth of a volt, are used to control bushing temperatures. These are held within 0.25F. (Item H-3)

GAS MIXING STATION GOES ON FULL AUTOMATIC IN HALF A DAY

This system normally utilized natural gas, but since a propane-air mixture must be used as standby, a gas mixing station was installed. Key item in the station was a standard Hagan Dual Ring Balance meter equipped with ratio control. Flow to equipment in the gas line is measured by one ring. This signal is used to control the flow of propane, which is measured by the other ring. The established ratio, resulting in a 1200 Btu propane-air mixture, is maintained throughout the range of the meter. This type of proportioning control is exact and is useful in a great many applications, including chemical feed and combustion control. The meter was installed and placed on full automatic in half a day's time. When, at a later date, demand on the station changed, the Hagan meter was changed to the new, higher range by a simple and easily made field adjustment. (Item H-4)

HAGAN CHEMICALS & CONTROLS, INC.

Hagan Building, Room 707, Pittsburgh 30, Pennsylvania
In Canada: Hagan Corporation (Canada) Limited, Toronto
European Division: Via Flumendosa No. 13, Milano, Italy

If you would like more information on any of the above items, check the appropriate box below.

☐ Item H-1 ☐ Item H-2 ☐ Item H-3 ☐ Item H-4

For more data circle 531 on Post Card

LONG LIFE WITH NO LUBRICATION...

The Joy T-block design compression rings are an exclusive Joy feature with patents pending.

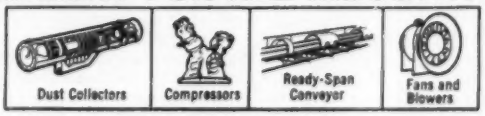
exclusive T-BLOCK design doubles life of piston rings on JOY oil-free compressors

All Joy oil-free compressors are equipped with carbon-graphite piston rings of T-block design. They require no lubrication and compensate automatically for wear. Blow-by is virtually eliminated for the life of the ring. Brass expanders and stainless steel springs operating in teflon sleeves provide the piston rings with controlled pressure evenly distributed on the cylinder walls. Result: "bug-free" operation and freedom from corrosion. Compressor owners report ring life of 8000 operating hours, and more.

If your operations require oil-free compressed air, whether for instrumentation or for processing, get complete details from Joy. A complete line of oil-free compressors is available from 95 to 3600 cfm, 15 to 600 hp.

Ask for free bulletin 301-56C.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



WBW I 7819-901

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

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CONSTRUCTION NEWS

Tuscumbia, Ala. — Tennessee Valley Authority, New Sprankles Bldg, Knoxville, Tenn, has announced contract award in excess of $10,000,000 to the Babcock & Wilcox Co, Boiler Div, 161 E 42nd St, New York, N. Y., to provide the boilers and auxiliary equipment for the agency's Colbert Steam plant to be located here. Contract included cost of renting special tools and rigging equipment necessary to install the boilers to be used with the 500,000-kw turbine generator which TVA has agreed to purchase from a British firm, C. A. Parsons, Ltd. Work will get under way soon for completion by late 1962.

Fairbanks, Alaska — The Senate Public Works Committee has directed Army Engineers to go ahead with a study on the proposed construction of Ramport Canyon Dam, to be built on the Yukon River, 90 miles northwest of this city. When completed, it will be the nation's largest hydroelectric facility and will create a lake so large that meteorologists claim it will help warm interior Alaska. Preliminary reports from the Chief of Army Engineers, Brigadier General E. C. Itschner, indicates a schedule of 13 years between the start of planning and completion. By that time it is estimated that the new state will have a population in excess of 2,000,000.

Eureka, Calif. — Pacific Gas & Electric Co, 245 Market St, San Francisco, Calif, has announced filing of a formal application with the U. S. Atomic Energy Commission for permission to build proposed Humboldt Bay Atomic Energy Power Plant near here, and previously announced in these columns. Company plans to begin construction work in the spring of next year. Application filed with the AEC seeks permission to build a 50,000-kw power reactor which is expected to produce power at a substantially higher capacity later. Plant will require about two years to build and will cost an estimated $20,000,000 upon completion. Application was also filed with the California Public Utilities Commission.

Los Angeles, Calif. — Southern California Edison Co, 601 W Fifth St, this city, has authorized the expenditure of more than $110,000,000 to go toward new generating facilities and plant equipment this year, following an expenditure of $151,000,000 in 1958, with completion of two generating units with an operating capacity totaling 435,000 kw at company's Huntington Beach Station. A third unit with an initial capacity of 220,000 kw has been authorized at this location, and contract for construction has been placed. New unit, cost of which was not announced, is expected to be placed in line before 1962.

Hartford, Conn. — Connecticut Light & Power Co, 266 Pearl St, has announced plans for improvements and extensions of company's distribution facilities in service areas, to cost in excess of $3,000,000. Work will include transmission lines from Derby Tap to Beacon Falls, from Glenbrook to Norwalk rebuilding and converting 69-kv transmission line from Montville to Willimantic to 115-kv capacity. Work will also include a new transmission line to Southington, Conn, where a new substation is already under construction. Work is under way.

Wilmington, Del. — Delaware Power & Light Co, 600 Market St, has announced plans for the expenditure of approximately $93,000,000 for expansion of power generating facilities, distribution lines, and other company facilities over the next five year period. Construction and new equipment will enable company to meet fast growing requirements of the Delmarva Peninsula. Major undertaking in the program is the addition of a 150,000-kw steam-electric generating unit at company's Edge Moor Power Station. Construction is planned to get under way in the summer of next year for completion by about 1962.

Chicago, Ill. — Commonwealth Edison Co, 72 W Adams St, has announced contract awards for a new steam-electric generating unit that will increase capacity of company's Waukegan Station to more than 1,000,000 kilowatts. Bechtel Corp, San Francisco, Calif, has been named construction engineer of the project; Westinghouse Electric Corp, Pittsburgh, Pa, will furnish the turbine generator; and Combustion Engineering Co, Inc, New York, N. Y., will supply the boilers and auxiliary equipment.

Guttenberg, Iowa. — City Council of the City of Guttenberg, City Hall, has plans under way for the construction of new boiler room and facilities at Guttenberg Municipal Hospital, this city. Plans call for the erection of a two-story steel frame masonry boiler room 91 ft wide and 133 ft long to house new boilers and auxiliary equipment. Work will get under way late this year for completion by late 1960. Estimate of cost is $500,000.

Wichita, Kans. — Kansas Gas & Electric Co, 201 North Market St, has plans under consideration for the construction of new power plant in West Wichita. Large tract of land was recently acquired for the purpose and company proposes to construct the first unit with an initial capacity of 160,000 kw in the spring of 1960. Installation of the new unit at this station to be known as the Gordon Evans Power Plant is reported to cost $8,000,000.

Morristown, N. J. — Jersey Central Power & Light Co, 501 Grand Ave, Asbury Park, N. J., has authorized plans for the construction of a new headquarters building and administration facilities on large building site here. Company has awarded contract to the William Blanchard Co, 45 Poinier St, Newark, N. J., estimated to be about $3,000,000 for construction of the facility.

Cleveland, O. — Cleveland Electric Illuminating Co, Illuminating Bldg, this city, has announced plans for a major expansion which involves a major rebuilding and modernization of company's Lake Shore Power Plant. Older parts of the present plant will be torn down to make way for the installation of a new 250,000-kw steam generating unit. New unit will replace a combination of seven turbines and 36 steam boilers and will be one of the largest in the country supplying power needs for more than 300,000 homes. Operating target date is scheduled for the summer of 1962 and the cost reported to be about $40,000,000.

Saxton, Pa. — Formation of a new corporation to spearhead development of a small nuclear reactor to power a Pennsylvania generating plant was announced jointly by the New Jersey Power & Light Co, Dover, N. J. and Jersey Central Power & Light Co, of Asbury Park, N. J. A water type reactor will be constructed by Westinghouse Electric Corp, Pittsburgh, Pa, and will be located in a sparsely populated area in a mountainous region of Bedford County, near here. Steam, or heat energy, resulting from operations of the nuclear reactor, will be used to drive existing turbine generators in the Saxton generating station of the Philadelphia Electric Co. Company officials expect the research and development program to extend over a seven-year period.

Knoxville, Tenn. — Tennessee Valley Authority, New Sprankles Bldg, Knoxville, Tenn, has announced that the agency has requested bids, foreign and domestic, on 16 massive new steam turbine-generators. The Authority is seeking bids on new machines which will have a total rated capacity of more than 6,000,000 kilowatts or some 12 times more than the value of award which went to C. A. Parsons, a British concern, and thereby touched off an international controversy.

Oak Ridge, Tenn. — Atomic Energy Commission has revealed plans by Vitro Corp, 261 Madison Ave, New York, N. Y., for the erection of a pilot plant here, at Oak Ridge National Laboratory, for chemically reprocessing radioactive material from nuclear power plant fuels. Commission plans to combine three existing chemical pilot plants with new facilities consisting of a central structure to house operating and administrative areas; a process cell block and sampling gallery; a storage canal and unloading pit including a demineralizer and decontamination pit. Work planned will also involve modification of existing facilities already located here. Cost reported in excess of $3,500,000. Work begins late this year for completion by early 1961.

Hanford, Wash. — The Atomic Energy Commission has announced plans for the construction of a large plutonium-producing reactor that could eventually be converted into one of the largest atomic power plants on large site here recently selected for the purpose. As a dual purpose reactor producing plutonium for weapons as well as electricity, the plant would rank among the largest in the world with a capacity of between 300,000 and 900,000 kw. The plant will cost an estimated $145,000,000 when completed.

Washington, D. C. — The Atomic Energy Commission, 1901 Constitution Ave, N W, has announced that it has selected as a basis for contract negotiations the proposal of the General Electric Co, San Jose, Calif, for performance of research, development and design of a fast breeder reactor using a plutonium oxide-uranium oxide fuel cycle. Proposal was selected from among eight received in response to an invitation issued by the AEC last fall. Commission will award a cost-type contract for the work estimated at $500,000; it will take a year and a half to complete.

pressure seal gate valves ... made the POWELL way

600, 900, 1,500, 2,500 Pounds
and Higher—all commercial sizes

Powell Pressure Seal Gate Valves offer many superior features. A few are:

- Streamline flow passage makes possible maximum flow with minimum turbulence.
- Outstanding simplicity of design, smooth body contour and weight reduction assure easier installation, greatly reduced insulating costs, and a marked saving in space.

Powell Pressure Seal Valves are also available in Globe, Angle and Check patterns.

For all your valve needs, consult your local Powell distributor—or write directly to us.

THE WM. POWELL COMPANY
Cincinnati 22, Ohio
Dependable Valves Since 1846

POWELL...world's largest family of valves

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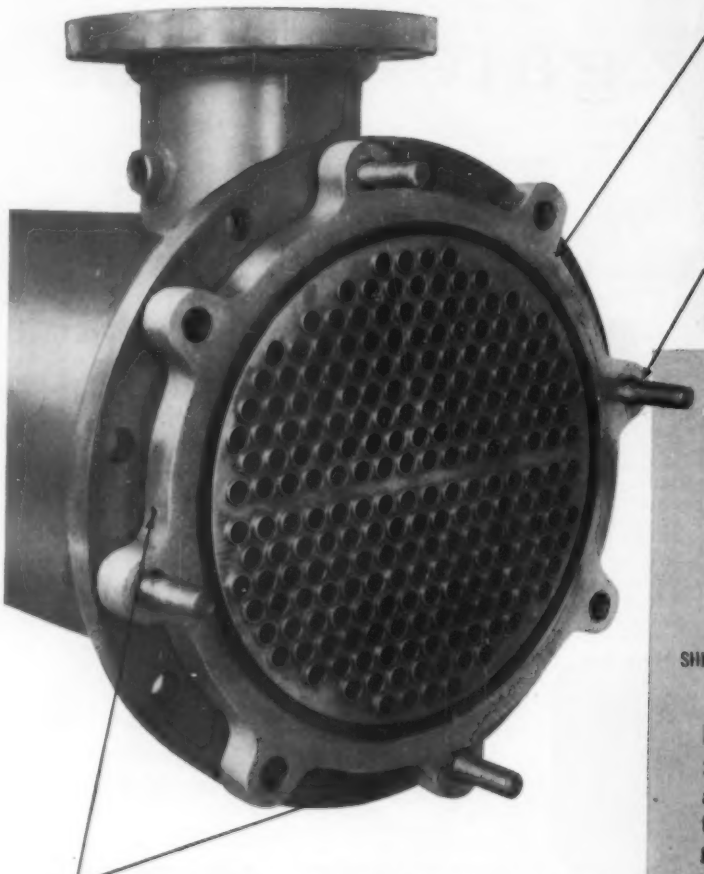
Simply remove the bonnet to make a shell side pressure test

Paracoil

EXCHANGER TYPE **PC**

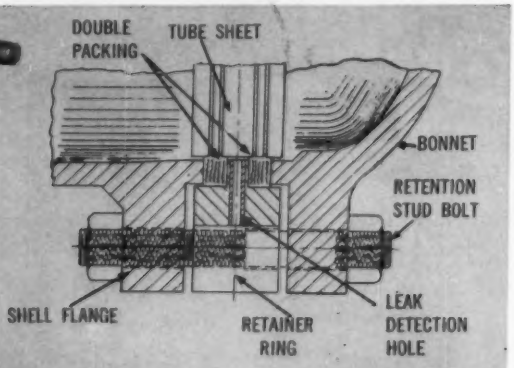
FOR ☐ COOLING ☐ HEATING

☐ OIL ☐ WATER ☐ AIR ☐ GAS



Unique retainer ring permits fast, easy inspection and servicing of packing. All that is necessary to set up a shell side pressure test is to remove the end bonnet by backing off on its single set of holding nuts. The retainer ring continues to hold the shell side packing in compression (see details below). No clamps or special devices needed. Piping connections are left undisturbed.

Retention stud bolts pass through the shell flange and screw into threaded retainer ring lugs, holding the ring and packing in place with bonnet off.



HOW IT WORKS

Section at packing retainer ring weephole. Seepage from either shell or tube sides drips out through copper-lined weephole. If tightening the gasket compression nuts fails to stop the leak, simply remove the end bonnet and pressure-test the shell side to locate the trouble—either the tube-end rolling or the shell-side packing. If neither, then the tube-side packing is at fault.

PARACOIL TYPE PC EXCHANGER

Leak detection holes at each 90° point in the retainer ring reveal any leakage past either the shell or tube side packing. **The absence of leakage indicates that the packing is holding—hence no dismantling is necessary for packing inspection.**

PARACOIL PC Exchanger tubes are straight for easy cleaning. The tube bundle is fully removable.

THESE DESIGN FEATURES SAVE HOURS OF MAINTENANCE TIME EVERY INSPECTION.

For details, write for Bulletin 140-A

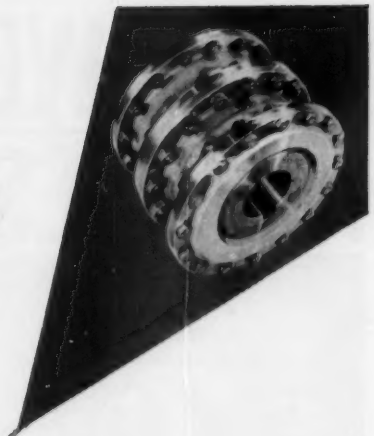
DAVIS ENGINEERING

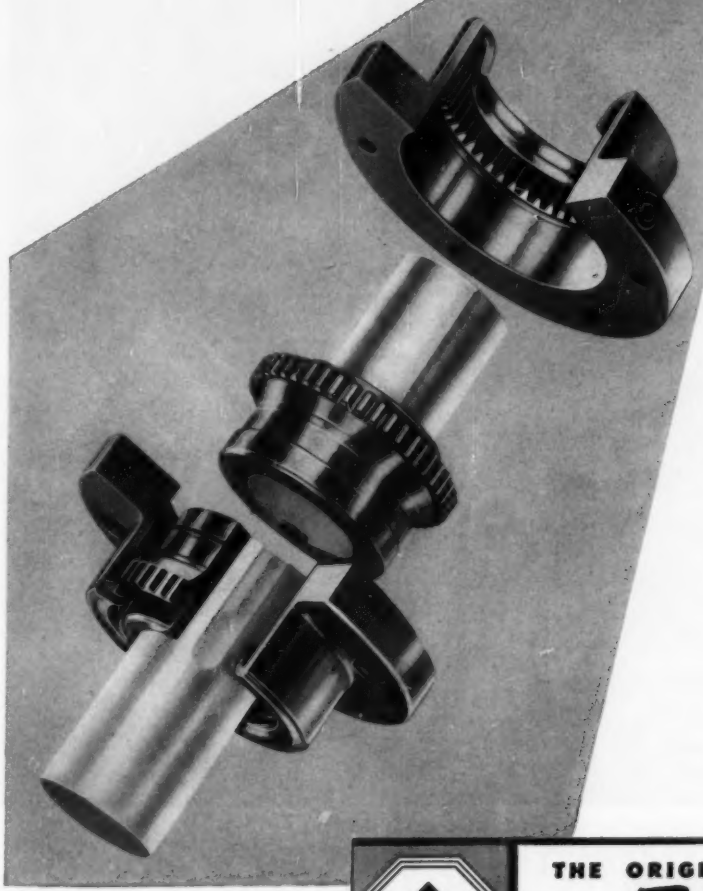
(A Division of American Metal Products Company)

520 Main Avenue, Wallington, N. J.

For more data circle 534 on Post Card

the basic coupling principle that couldn't be improved . . .





This principle makes every Fast's coupling . . . large or small . . . out-perform all others

The principle embodied in Koppers gear-type, self-aligning Fast's couplings couldn't be improved by anyone. Throughout industry, Fast's couplings are accepted as the most dependable couplings on the market. Experience has proved that they frequently *outlast the equipment* they connect.

Fast's couplings are sufficiently comprehensive in types, sizes and versatility to meet almost every known need for couplings. Available in forged steel for shaft sizes from ¾″ to 6⅜″ and in cast steel for shaft sizes from 5½″ to 32″.

Nearly 40 years of coupling experience guarantees that Koppers can supply the right coupling engineered for a given application. For the booklet describing Fast's couplings applicable to your equipment, write today to: KOPPERS COMPANY, INC., Fast's Coupling Department, 5207 Scott Street, Baltimore 3, Maryland.

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THE ORIGINAL

FAST'S Couplings

Engineered **Products Sold with** ***Service***

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ONLY WELBOND® COMBINES ALL THESE VALVE FEATURES

These features have won immediate approval for Yarway Welbond Valves in steam power plants everywhere. Now available in 9 sizes, ¼" to 2½", angle and straightway. Pressures to 2500 psi, temperatures to 1050°F. Write for Bulletin B-453.
YARNALL-WARING COMPANY
100 Mermaid Avenue
Philadelphia 18, Pa.
Branch Offices in Principal Cities
NEW VENTILATED HANDWHEEL
GUIDED STEM OF 321 STAINLESS STEEL
—will not "pit". Self-aligning valve disc
HIGH TEMPERATURE INHIBITED STEM PACKING
—furnishes double insurance against packing leaks.
ONE-PIECE BODY AND YOKE
ACCESSIBILITY
—all working parts readily removed through yoke. Jack action of stem forces out old packing.
UNIQUE SEAT DESIGN
Thermal compensating groove prevents distortion when welding valve in line and permits perfect seating of disc for positive seal.

YARWAY WELBOND ... *is the valve for high pressures/high temperatures*

REPRESENTATIVE USERS OF YARWAY WELBOND VALVE: Houston Lighting & Power Co. Jersey Central Power & Light Co. Boston Edison Co. Virginia Electric & Power Co. Connecticut Light & Power Co. City of Independence, Mo. Aluminum Co. of America City of Pasadena, Calif. Mississippi Power & Light Co. Rochester Gas & Electric Corp. Ohio Edison Co. Central Hudson Gas & Electric Corp.

For more data circle 536 on Post Card

TRACERS

Power Engineering's Monthly Probe of Power Facts

Gas turbines for "peak shaving" will be used experimentally by Philadelphia Electric Co; so will a package-type, remote-controlled, unattended diesel unit made by General Motors. The diesel has been under test for a number of months, is expected to supply 6 mw during peaks. The two gas-turbine-generator combinations are 20.5-mw and 22-mw simple-cycle units, are being made respectively by GE and Westinghouse. Duquesne Light Co is also looking to gas turbines for peaking service.

Sewage plant effluent, properly treated, can be used successfully as cooling tower make-up water. Whitewater Valley generating station in Richmond, Ind, is an instructive example of this way of solving water supply shortage. See T. C. Hoppe's article on page 71.

New type of arc suppression device is announced by the Square D Co. It is designed to control the problem of erosion and oxidation of the control contacts by the arc produced when the circuit is interrupted, and also the problem of puncturing of control wiring and operating coil insulation by the voltage peak developed by the collapsing magnetic field.

Closed-chest defibrillator, a newly perfected device which makes possible the restoration of normal heart rhythm by means of electric currents sent through the heart from electrodes placed on the surface of the chest, has been introduced by Edison Electric Institute. The Institute supported the research on the device at Johns Hopkins University. The defibrillator is for use in cases where normal rhythm of the heart is interrupted and thrown into a twitching state known as ventricular fibrillation, as in some instances of electric shock.

Need has long been felt for a better way to obtain turbine vibration data. Now Westinghouse has perfected an instrument system which continuously records the X and Y components of vibration. This important new technique is presented to the power field for the first time, page 63.

New process which converts any sodium-based sulfite liquor to kraft-type liquor has been demonstrated by Consolidated Water Power and Paper Co and Western Precipitation Corp. It's called the W-P Recovery Process, and is described on page 82 of this issue. Advantages: valuable chemicals used in paper making are recovered, steam is produced for process and power as a by-product, and BOD on neighboring streams is reduced.

Protective relays completely devoid of moving parts mark the first change in basic relay design in a long time. Two companies have announced they will market such relays. See our article on page 70.

Electric Transmission Lines—How

Here is the complete story of how a typical electric transmission line is conceived, designed and constructed. This is the first of several articles and is written by a power engineer who has had many years' experience in all phases of electric utility construction

By E. P. NANEY *

About the Author

Mr. Naney has spent his entire career in utilities. He started as a draftsman for Indiana Power Co; later, he transferred to Interstate, at Dubuque, Iowa. Excepting a few years with an affiliate company, Mr. Naney has been with Interstate continuously. His positions included Construction Engineer, Transmission and Distribution Engineer, Asst. to Chief Engineer, and Chief Electrical Engineer.

INTERSTATE POWER CO operates an electric utility system in one of the richest farming areas in the Midwest. This area is in northwestern Illinois, northeastern Iowa, and southern Minnesota.

It is apparent from the area served that this one company operates an extensive transmission system. The company has been conscious, over the years, of the necessity of getting the most transmission service for the lowest transmission construction dollar.

Some of the things we have done to accomplish this are: — 1. Early exclusive use of steel-reinforced conductor (as far back as 35 years ago), which permitted economical long-span construction; 2. Initial design, and use, of double-plank arm X-braced, H-frame structures (as illustrated in Fig. 3); 3. Pioneering (in conjunction with Westinghouse engineers) in the use of expulsion tubes on unshielded steel tower lines (illustrated in Fig. 4); 4. Developed the use of a V-string to limit the swing of the middle phase, which permitted additional insulation to be installed on all phases; and, 5. Design of the top of steel towers which has become quite prevalent for higher voltage lines over the years (see Fig. 4).

With this background of experience, our transmission and construction engineers have developed techniques of engineering and installation that would be informative to the readers of POWER ENGINEERING.

System Planning Important

Transmission has made it possible to locate power plants at the most advantageous location, as far as cooling-water supply and economical fuel are concerned, without regard to location of load-centers. Transmission interconnections (with neighboring utilities) have contributed substantially to the reduction of unit-installed generating costs by permitting larger units to be installed, and by pooling reserves. Transmission facilities of a company and its generating stations are closely allied and are dependent on each other for production and distribution of power. A good transmission system contributes to the most economical operation of its production plants.

In the early development of systems involving interconnection of power plants, *wood pole* lines were used most generally. During this period the life span of a transmission line was about 15 to 20 years. This was because the art of extending the life of poles and arms by timber treating processes had not been fully developed. Consequently, the lines were designed for a specific voltage, with the insulators installed accordingly. The conductor was small because of the realization that it would be replaced in a reasonably short time, due to physical deterioration.

Present day transmission lines continue to utilize wood pole structures, but their life expectancy has advanced tremendously — 100 per cent; or to 35 or 40 years. This is due partly to timber preservation techniques, improved conductor, improved steel hardware, better galvanizing, and improved design of insulators. The design engineer has added engineering techniques to improve life expectancy, also.

At the present rate of load growth of electric utilities (doubling every ten years), a 40-year period represents an over-all increase in load of at least 1600 per cent. Therefore, any transmission line built today, on the basis of pure physical life expectancy, can be expected to serve a load increase of sixteen times present value. This poses some important economic criteria for the transmission engineers with respect to both the transmission lines and their terminals. They must satisfy the requirements of long-term load growth, as well as short-term necessity. Most of these planning decisions are a compromise, based on what the near-term earnings of the company will support, and still satisfy the long-term growth requirements.

This usually may be resolved in a number of ways: by designing the structure to accommodate increased conductor size at some later date; by providing structures that will readily convert to a higher voltage; or, by planning for multiple-circuits of the

* Chief Electrical Engineer, Interstate Power Co, Dubuque, Iowa

to Design and Build Them

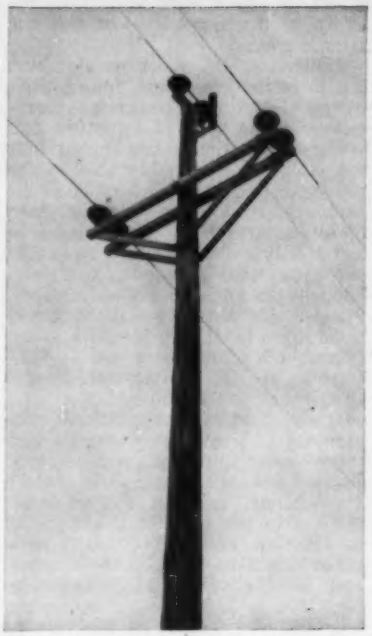


Fig. 1. Standard construction for 34.5 kv

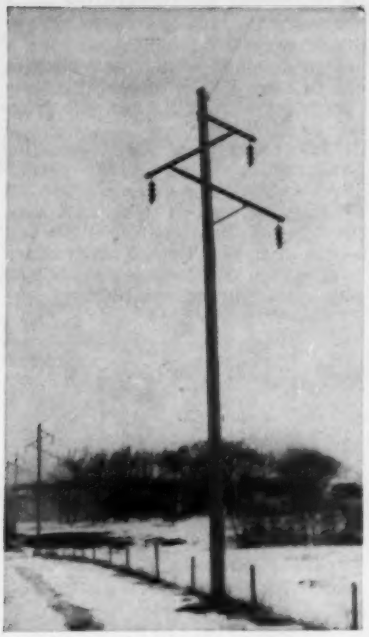


Fig. 2. Z-type pole-head, for 69-kv line

Fig. 3. H-frame for 69 kv, heavy wire

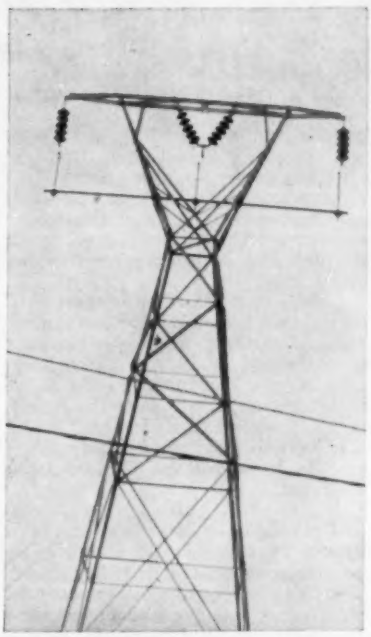


Fig. 4. Standard steel tower fixture

ultimate voltage selected for the long term.

For both short-term and long-term planning, Interstate makes use of a network analyzer. In coöperation with other utilities in the Midwest, we have arrangements for use of time on network analyzers at both Iowa State College and Illinois Institute of Technology.

Our company has two or three standards of transmission construction that adapt readily to an increase in capacity. Figure 1 is a pin-type configuration, used at 34.5 kv, which can be converted to 69 kv by replacing the insulators and protective expulsion gaps only. By doubling the voltage, the capacity of lines so constructed can be increased by 400 per cent. This is an economical type of construction for use during the lighter-load-density periods of the early years of planning; yet it gives a good account of itself, service-wise, by having good phase-to-phase clearances. This is due to the triangular construction; and, by having good protection from lightning (by use of expulsion gaps), the top conductor serves a dual purpose of phase-wire and shield-wire.

Figure 2 shows our standard type of construction for 69 kv. This type is used where heavy conductors are required. It is not adaptable to a voltage raise; and, for capacity increase, multiple lines would have to be constructed. Or, intermediate supply points would have to be installed, from higher-voltage transmission lines, to increase the capacity (by shortening the line length).

Interstate's standard construction for 161 kv is shown in Fig. 7. We have a number of lines that are constructed for this voltage, operating at 69 kv. When converted from 69 to 161 kv, the capacity is increased 700 per cent. The extra conductor spacing, pole height, and insulation represents only a 20–30 per cent increase in cost (at the time of installation) over a 69-kv line of the same conductor size.

Our present thinking is that multiple 161-kv lines would seem to satisfy our requirements for long-term use, on the basis of present plant locations at approximately 100-mile intervals on the system.

Transmission Line Design

In designing a transmission line, there are a number of points to consider. The more important are: 1. Is the service over the line important enough to make it as completely lightning-proof as possible — that is, should the line be shielded; 2. What voltage shall be selected which, with the wire size selected, will satisfy the immediate load requirements with a tolerable voltage drop and power loss; 3. Will the structure design withstand the effects of heavy ice, low temperatures, and high winds; 4. Having selected a conductor (and a type of structure), what are the relationships between these and the span length on the line; 5. Will the structure be adaptable to increases of conductor size, or increase in operating voltage, or both?

A transmission line may be shielded from the effects of heavy lightning strokes in one of two ways. One is the installation of a shield (or ground) wire above the phase wires, located in such a position that a lightning

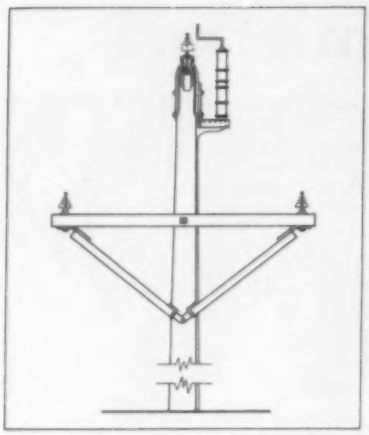


Fig. 5. Drawing of 34.5-kv pole-head with expulsion-gap near top conductor

stroke will hit the overhead shield wire and dissipate to ground. (The shield wires are illustrated in Figures 6 and 7.) A second method of shielding against lightning is to place one of the phase wires above the other two, in a shielding position, and drain off any lightning discharge through an expulsion type tube or arrester. This is illustrated in Fig. 5, mentioned previously.

In addition to the *position* of the shielding conductor (with respect to the phase conductor), its effectiveness is also improved quite substantially through the means of a low-resistance ground at each structure, and through adequate mid-span clearances between the shielding conductor and phase conductor. There should be sufficient insulation between phase conductors and supporting structure and a sufficient air-gap between the phase conductor and the ground lead on the pole, to prevent flash-overs.

All these relationships, when properly coördinated, establish a lightning discharge level for the line.

From field data, accumulated by research and instrument recordings over a period of years, the average number of thunderstorms per year has been established and made a matter of record. Probability curves have been made from this data on the intensity of lightning discharges. As an example, assuming thirty thunderstorms passed over a square-mile area during a lightning season, the number of excessive discharges due to lightning could be fairly well predicted.

Engineers have curves which illustrate the permissible stroke-current (in amperes), which have been factored to show the probability of outages, per hundred miles per year. The main variables are the amount of insulation applied on the line and the resistance of the pole ground-wires, under the assumed storm conditions of thirty storms per year. For example, we use ten insulators per string on 161-kv construction; and, by means of deep-driven grounds, keep the ground resistance at the pole to not more than 10 ohms. On the curves, the 10 insulator value intersects the 10-ohm curve at approximately 0.75, indicating that a line so designed would have outages not to exceed 0.75, or less than one outage per hundred miles, per year, due to lightning.

Main trunk transmission lines interconnecting power plants should have a low-outage record due to lightning, as well as to other causes. Such lines ordinarily transmit heavy blocks of power. Even a momentary interruption could cause serious system disturbances and possibly system instability, which might tend to split the power sources apart. Multiple interconnections with neighboring utilities have reduced these consequences to a marked degree, but a shielded line is still a necessity for this duty.

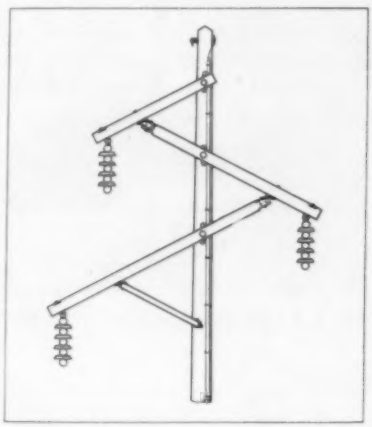


Fig. 6. This sketch shows details of fixture in Fig. 2. Used for 69-kv line

Lower-voltage lines necessarily carry less loads, and have less system duty to perform, insofar as stability is concerned. Even on these lines, high service continuity becomes increasingly important from the standpoint of service to customers. Therefore, a good lightning-proof design on the lower-voltage lines is most desirable.

Where triangular configuration and expulsion arrester is used (as in Figure 1), this method serves as an economical means of providing shielding for lower-voltage lines, constructed on pin-type insulators, and in triangular configuration. Shielding action is this: — lightning strikes the top phase conductor in the apex position, but, instead of flashing over the insulator (from phase wire to ground wire), the lightning flashes across the gap from the phase wire to the arrester tube and the discharge is dissipated. Such a short time is involved that no 60-cycle power current can flow. In other respects, the relationship between the top wire and the other two wires, the insulation, and the ground resistance is the same, as if the top wire were strictly a shield wire insofar as the lightning discharge level of the line is concerned.

Interstate, in selecting standard design structures, has found that ranges of conductor sizes relate themselves to the type of structure and voltage. Experience has shown that 4/0 ACSR is very adaptable to the pin-type lines that must later be converted to 69 kv. For standard 69-kv construction, a *minimum* of 4/0 ACSR is also used, but two other sizes are used frequently; namely, 336,500 cm and 477,000 cm, ACSR. For the H-frame types of construction, where 161 kv ultimately is anticipated, a minimum would be 477,000 cm, ACSR, and the next selection would be 636,000 cm.

Under ordinary conditions, the nominal and maximum length of a transmission line (from power source to load center) falls into a pattern for different voltages. For 34.5 kv, the maximum distance might be 30 to 35 miles. For 69 kv, the distance range might be from 60 to 70 miles; and, for 161 kv, the range might be from 100 to 150 miles. The conductor, and the length of the line as given above, will give a reasonable voltage drop (and power loss limit) at the surge impedance capacity of the line (3000–4000 kva for 34.5 kv, 12,000 to 16,000 kva for 69 kv, and 85,000 to 110,000 kva for 161 kv).

Editor's Note: Next parts of this article continue with design and engineering, and take you through every step of construction. Don't miss them.

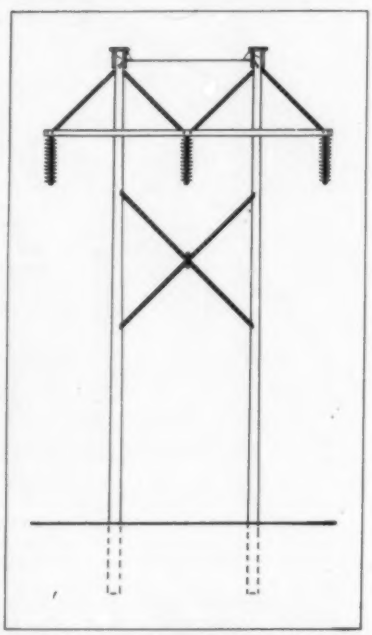


Fig. 7. Details of standard construction used for 161-kv lines, H-frame type

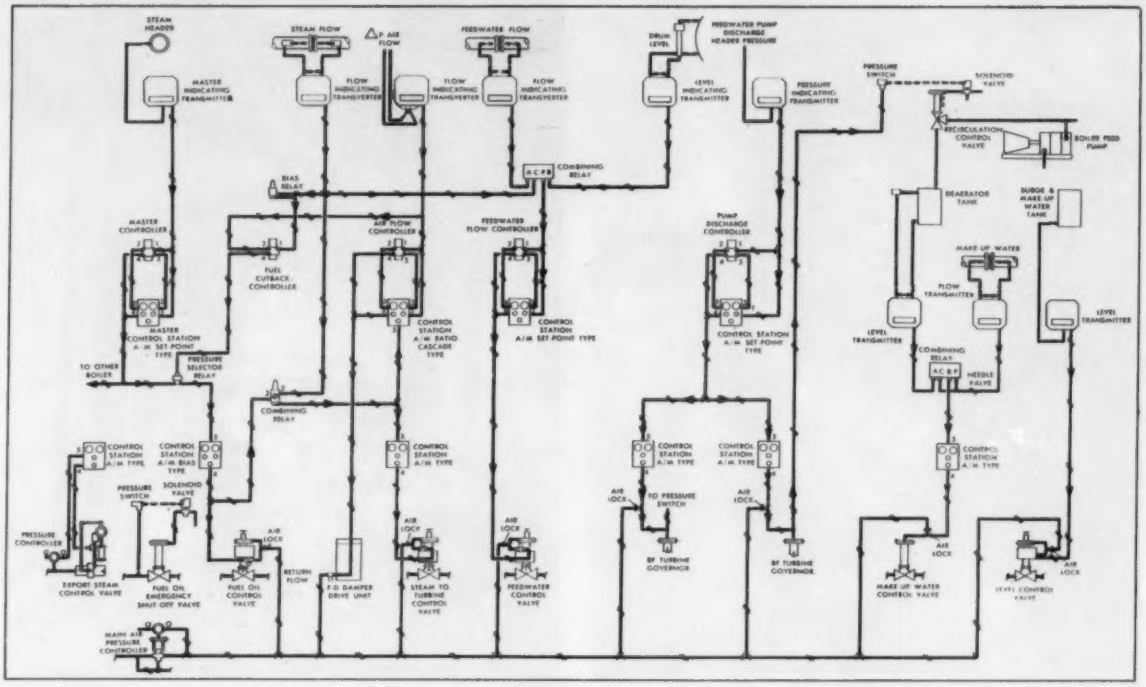


Fig. 1. Schematic of the boiler control system shows how fully-automatic operation of the low pressure boilers is attained

Atlantic City Electric Designs For Steam System Flexibility

An electric utility taking on added responsibility of supplying process steam for a complex industrial plant faces many problems affecting design and operation. Here's how one company met them

By O. H. KEELING*

WHEN AN electric utility takes on the added responsibility of supplying extraction steam for a large industrial process plant such as a complex chemical works, it is faced with two major problems: that of assuring adequate service to both electrical power and steam consumers, plus incorporating the necessary operating flexibility required to maintain a reasonable over-all plant efficiency.

Atlantic City Electric Co met the basic requirements at its Deepwater Station by supplying most of the process steam from two large 1310-psi boilers by turbine extraction and/or pressure reducing-desuperheating stations. Process involved requires steam at 230 psi and saturated temperature.

Necessary flexibility for handling unusual peaks, facilitating efficient high-pressure boiler loading, and standby for maintenance outages was obtained by installing two automatically controlled, oil-fired Wickes-type RB low-pressure boilers feeding directly into the process plant steam line. Each boiler has a continuous rating of 140,000 lb per hr and is capable of operating from a peak of 200,000 lb per hour down to 20,000 lb per hr to meet widely and seasonally fluctuating process demands.

Boiler control system was designed and manufactured by Copes-Vulcan Division of Blaw-Knox to meet the requirements of controlling the steaming rate with either one or both boilers in service. Control is effective through all load ranges, and with each boiler carrying a different load when required.

Action Is Instantaneous

When in control, the system acts immediately to bring either one or both boilers from low load to maximum in the event either of the large process steam units or one of the small boilers should be lost. Control system action is based on remote transmitters sensitive to variables in the steam generating system; the transmitters send corrective impulses to relays and controllers mounted on the main control panel.

Combustion control system serving these two boilers was designed to maintain a constant pressure in the main process steam header by holding steam output equal to steam demand. Steam header acts as an expansion drum in which pressure is constant when the two conditions balance. When output becomes greater or less than demand, there is a proportional change in the header pressure. This change is used to motivate a signal to vary the boiler's fuel and air loading automatically, thus restoring steam production to that demanded by process.

Study of the schematic diagram, Fig. 1, will show how this is accomplished by the master transmitter, connected to the steam header, sending out a signal to the master fuel controller and its control station. The controller establishes a correcting impulse which modulates the boiler according to steam conditions. This modulated impulse then travels through an emergency fuel cutback pressure-selector relay to a fuel bias

* Manager of Control Engineering, Copes-Vulcan Div of Blaw-Knox Co

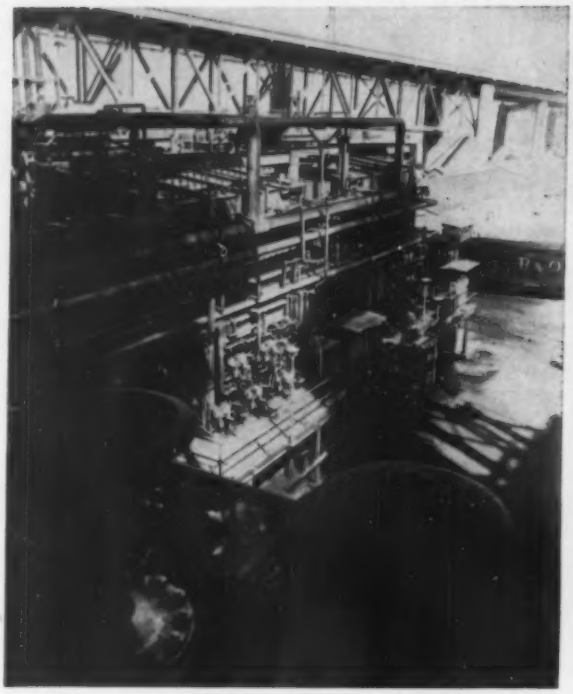


Fig. 2. Low-pressure boiler section at Deepwater is outdoors as is a great portion of automatic boiler control system

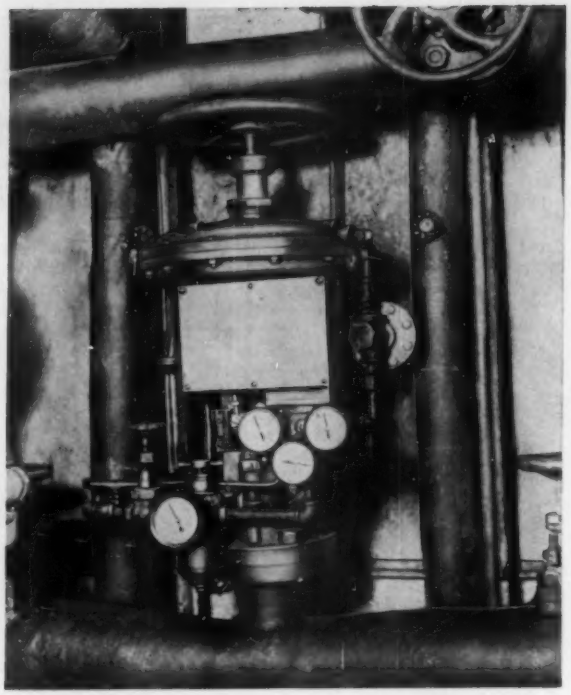


Fig. 3. Wherever necessary, control valves such as this have handwheels for manual operation under emergency conditions

control station (a manual adjustment for division of load between boilers) which relays the signal in two directions. One signal goes to the fuel control valve, the other to a combining relay. This relay temporarily adds the fuel loading impulse to the steam-flow transverter signal before it establishes the set point for air flow, and before it changes speed of the forced-draft fan turbine.

Air-flow control station relays this impulse to the air-flow controller, where it is balanced with a signal from the air-flow transverter. Output loading from this controller is sent to the forced-draft damper drive unit. Signal from the air-flow transverter also goes to a fuel cutback controller, which is set by a biased steam-flow transverter signal. Any steam flow-air flow spread that exceeds the desired bias starts cutback controller action to reduce the master fuel loading to the pressure selector relay in the circuit to the fuel control valve described earlier. Thus, a change in either steam flow, steam pressure, or air flow can originate a chain of events which operates to keep conditions in a state of safe equilibrium.

As a precaution against the potentially wide load swings which may appear on the process plant system, feedwater regulation is supervised by three influences: steam flow, feedwater flow, and drum level. Signals from these transmitting sources are sent to a combining relay. Here, the two flow signals are balanced against one another, while drum level signal normally causes the necessary corrective impulse to be sent to counterbalance the level set-point established at the control station. Controller output adjusts feedwater control valve position, and continuously returns the level to match the set point.

Control of feedwater pressure is through a pressure transmitter, a signal from which actuates a pump discharge controller. Impulses sent out by the controller go to the individual pump control stations and feed pump turbine governors. Each of the two pumps is protected against overheating on light loads by a recirculating control actuated by its loading impulse, sent out by the pump discharge controller. The recirculating circuit cuts in when pump flow drops below 12,500 lbs per hour, and closes when flow reaches 20,000 lbs per hour.

Another protective feature consists of a butterfly valve inserted in the export line to the process plant. Actuated by impulses sent out by a pressure controller connected to the line, the valve is closed automatically if the line-pressure falls to such level as to induce excessive delivery from the low-pressure boilers. This butterfly valve does not regulate or modulate; it simply closes to prevent serious boiler overload or excessive moisture carryover.

Emergency shut-off of fuel is also provided if fuel pressure drops below a predetermined safe level. Other standard controllers regulate the water levels in deaerator and surge and make-up tanks, to provide auxiliary services commensurate with needs of the automatically operated boilers. All control stations provide automatic-to-manual transfer without upsetting the system balance. This "bumpless" transfer is a simple matter of matching pointers and turning a knob.

This section of Deepwater Station is of outdoor-type design and has been subjected to ambient temperatures as low as 10 F. With exception of central control panel and its relays and controllers, most of control system is out-of-doors. Station design was by Gibbs and Hill, Inc. THE END

A REMINDER

Just a reminder that we still have reprints of the Power Engineers' Valve Manual on hand. Single copies are priced at $1 each. Quantity prices will be quoted on request. We feel that the Manual is one of the most complete and authoritative works on valves yet to appear. Every power engineer should make the Valve Manual a must for his reference library.

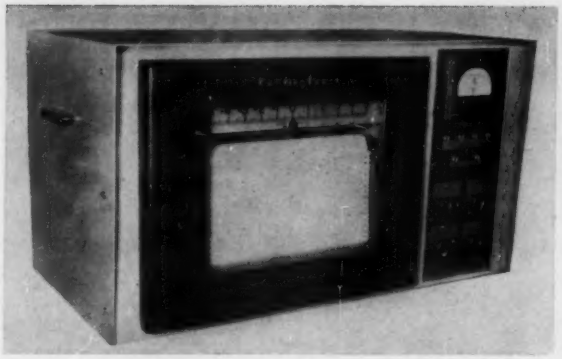


Fig. 1. Ten-point recorder records vibration components in four planes, plus machine speed and a point for calibration

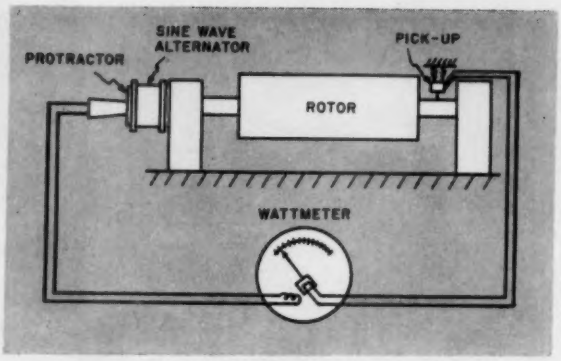


Fig. 2. Schematic diagram of the system used with the recorder. Each quantity monitored is recorded every 40 seconds

Recording Turbine Vibration Components Eases Trouble Analysis, Balancing

Filling a long-standing need, this instrument system continuously records the X and Y components of vibration, under conditions which may be varied at will. Detailed analysis of characteristics of the rotating mass then leads to appropriate corrective actions

By ROBERT F. CROUSE*

THE NEED FOR smooth operating machinery, to insure long trouble-free life, has become more apparent in the past decade. Machining tolerances have been steadily decreased and vibration-free operation has reached a point never before considered practical.

Large central-station turbine-generators, as well as large electric motors and related equipment, now have rotors which weigh up to 100 tons. These rotors are operating at speeds from 1800 to 3600 rpm and higher with shaft vibration held to within 0.001 to 0.002 in. double amplitude.

Many techniques and skills have been developed to analyze and control the various vibration problems which do develop, and in all cases, the crux of the situation is the obtaining of accurate, reliable data. Further, since many of the vibration problems are transient in nature, it is important that data be obtained as often as possible.

General practice has been to obtain this data manually, that is, an operator using some sort of portable balancing instrument would follow a set procedure necessary to obtain the data. He would be aided by several assistants who would hold the vibration pick-up against the vibrating body at those points where it would be desired to obtain this information.

This type of procedure has many inherent disadvantages which all have a decided effect on one's ability to properly analyze the problem and decide on a corrective course of action. Some of the factors which cause this type of data procuring to be ineffective and expensive are as follows:

Spot where the vibration is or should be measured is quite often somewhat inaccessible, extremely warm, and uncomfortable. This means that only a few readings, if any, can be obtained for any given time, and the chance for human error is apt to be large. Persons when doing this type work quickly tire and thus further increase the error.

When observing machines for extended periods of time, it becomes necessary to employ several shifts of men, each of whom has his own characteristic method of holding the pick-ups or obtaining the data. This difference between groups further complicates the problem being studied, to say nothing concerning the expense of employing several groups of men.

Result is that poor data is obtained. Corrective moves based upon these data often necessitate expensive shut-downs which do not fully correct the problem.

Improving Methods

Need for being able to better obtain this data has long been recognized and various methods have been tried. One which has recently proved to be very successful is the use of an X and Y-component recorder, which was developed by the research labs of Westinghouse Electric Corp.

Basically, the X and Y-component recorder was designed to be used in conjunction with the Westinghouse HQ Portable Balancer. Many large utilities have been using this type portable balancer for some time and have trained employees to operate it.

Type HQ portable balancer has been specially designed to determine the amount and position of unbalance weights in rotors, while the rotor is in actual operation. The equipment consists of a velocity-type magnetic pick-up, a sine-wave alternator, and a switching and metering unit, which is now replaced or supplemented by the X and Y-component recorder.

Calibration

Method used to obtain the vibration data is the familiarly-known wattmeter method, wherein the output of a two-pole sine-wave alternator, which is coupled to the rotor of a machine, is fed into the current coil of a wattmeter; and the output of the vibration pickup, which is held against a vibrating shaft, energizes the voltage coil of the wattmeter. Fig. 2 shows the schematic arrangement of the system.

Since the indication of a wattmeter is proportional to the product of the voltage amplitude of equal frequencies across its two coils multiplied by the cosine of the angle between them, it is possible with a given pickup voltage to make the meter indicate zero or a maximum. This can be accomplished by rotating the stator of the sine-wave alternator to certain positions where the two voltages on the meter are out of phase or in phase respectively.

* Westinghouse Electric Corp

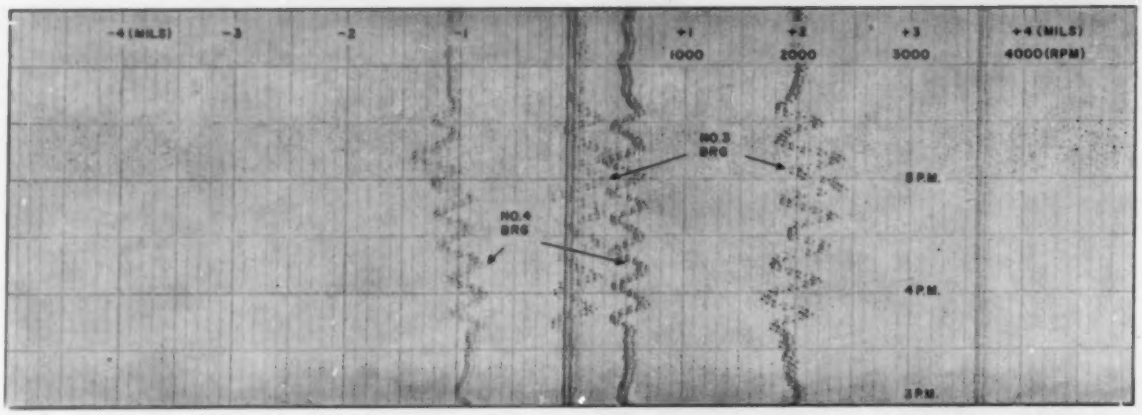


Fig. 3. Typical vibration recording, this one from a northeastern utility. Quantity recorded at right is the machine speed

The zero reading requires an accurate adjustment of the stator position. The angular position of the stator for zero reading is an indication of the phase angle of the pickup voltage, which voltage bears a fixed relationship to the vibratory motion. Therefore, the angular position of this stator will be referred to as the phase angle of the vibratory motion.

Shifting the location of a generator winding 90 deg from this zero position gives a maximum deflection of the wattmeter, and with the alternator current amplitude always held constant, this deflection is an indication of the vibration being measured.

When the switching and metering is used, the amount of vibration is read directly from a wattmeter in predetermined units, while the angular location of unbalance causing vibration is determined from the angular position of the movable stator, after an operating procedure has been observed.

If the X and Y-component recorder is used in place of the switching and metering unit, then the amplitude and location of the vibration vectors describing the vibration are measured and recorded in terms of the X and Y components of each vector.

Plotting the resultant of these X and Y components on a combination rectangular and polar chart will make it possible to make a direct conversion from the X and Y components to angle and amount.

Features

Chief advantage of using such a method as just described is that it effectively and positively filters out all vibration harmonics, except that frequency which corresponds to the running speed of the machine. This characteristic makes the apparatus particularly adaptable for measuring running frequency shaft vibration even when the shaft is being rubbed or is scored and is also out of round.

Another development which goes hand-in-hand with the X and Y-component recorder is the seismic mounting for the vibration pickups. This is referred to as a development because the latest type seismic mounting is very simple in construction and easy to use, as compared with seismic mountings which have been in existence.

Use of the seismic mounting in conjunction with the X and Y components results in a tool which eliminates or minimizes all those disadvantages which exist when the pickups are hand-held, as has been the common practice for many years. This is so because now a fixed set-up exists wherein the pickups are always held in the same position with the same pressure and are ready to measure the vibration continuously, which the recorder approximates.

Actually the importance of using seismic mountings and the X and Y-

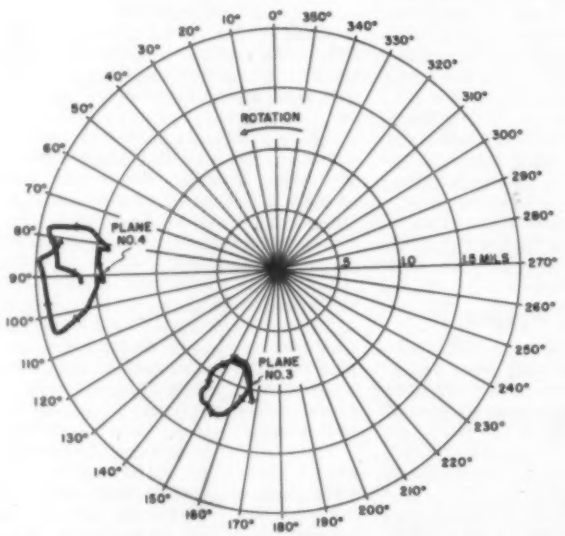


Fig. 4. Polar chart of the points recorded on the chart in Fig. 3 reveals progressive pattern opposite unit's rotation

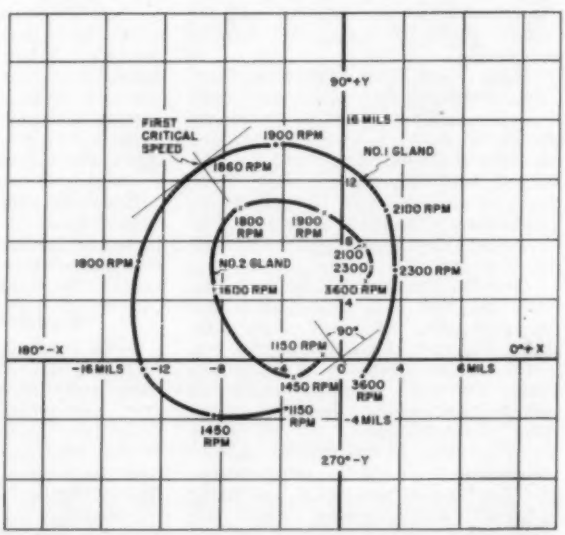


Fig. 5. Plot of the data obtained from the recording shown in Fig. 6, showing the effect of critical speeds on vibration

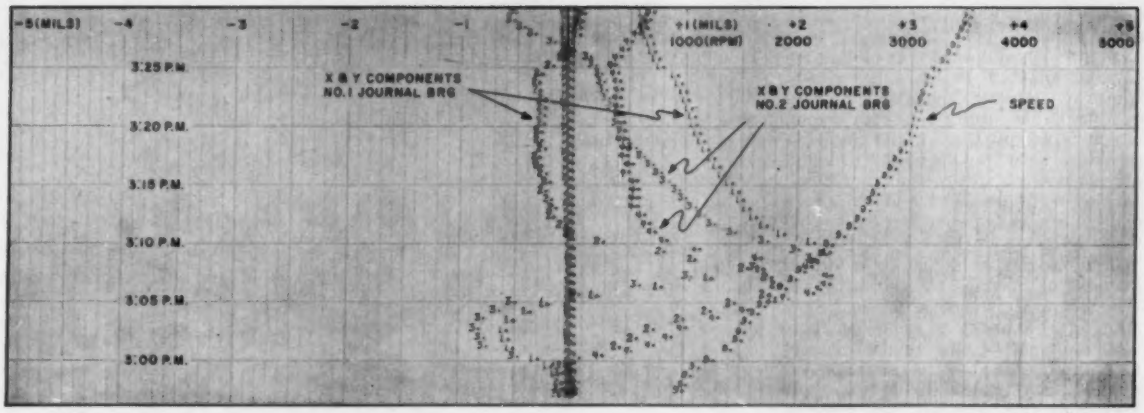


Fig. 6. Recording the vibrations of a midwestern turbine generator during acceleration determines critical speed readily

components recorder cannot be overemphasized as these devices tend to produce data more economically. This is so because after the original set-up is made there is very little attention required, thus eliminating the services of two or three men. Also the life of the equipment is greatly prolonged because chances of bumping or damaging are nearly eliminated.

Another economic advantage which might not be so apparent is that with the use of this type equipment better data is received, thus making it possible to make corrections with a minimum number of moves; this reducing the shutdowns of the machines being investigated to a minimum means additional savings to the utilities.

For recording the X and Y components of the vibration vectors, a ten point recorder is used in which eight of the ten points are used for plotting the X and Y components, making it possible to monitor four planes at one time. The ninth point is to record speed, and the tenth point is a calibration check point.

The recorder prints on paper which has zero at the center; plus components are printed on the right and negative components are printed on the left. There are two ranges so that each component can be from 0 to 5, or 0 to 15 mils in length.

A point is recorded every four seconds so that each variable is recorded once each 40 seconds. If it is desired to operate with only two pickups in place of four, then the frequency of plotting can be speeded by using jumper connections so that two points are printed for each component.

The right half of the recorder scale is also used for recording speed from 0 to 5000 rpm. This gives some indication of conditions imposed on the apparatus being observed.

Vibration problems experienced on central-station apparatus can be of any one cause or a combination of many different causes. These causes are usually complex and difficult to ascertain unless accurate data are obtained, and not just for any instant, but for prolonged periods. This is the reason why the components recorder had been developed to be used with what heretofore has been referred to as balancing equipment. This combination produces, in effect, an analyzer capable of recording continuously the vibration patterns which develop from various causes.

Considerable experience has been obtained in the past two years in the use of this recorder, in particular in analyzing some complex vibration problems existing on turbine generators located in various utilities about the country.

Figure 3 is a reproduction of a recording obtained when monitoring a vibration problem on a steam turbine located in the northeastern section of the country. The phenomena pro-

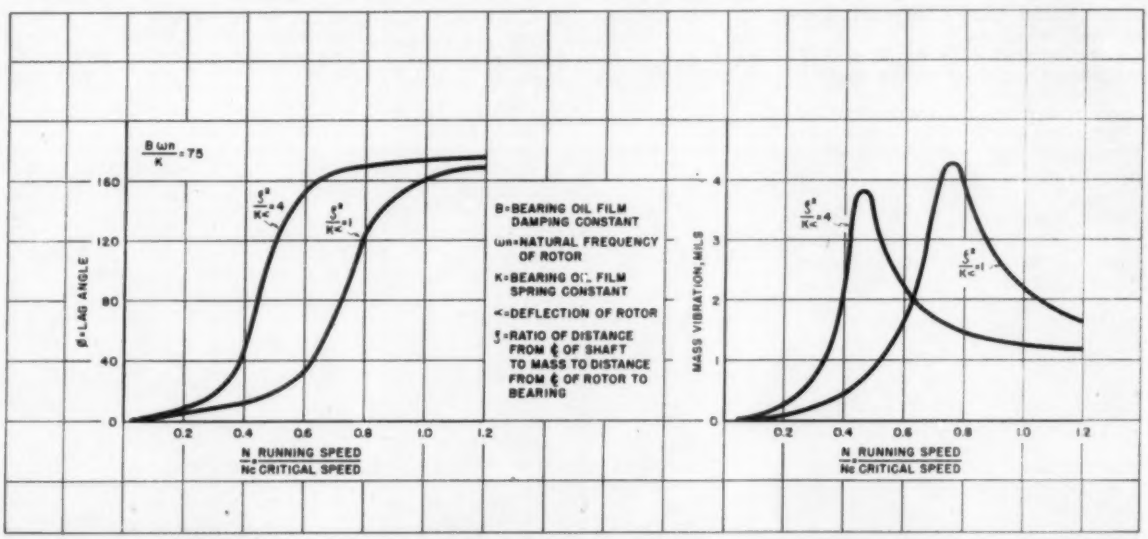


Fig. 7. Another plotting of data obtained from Fig. 6. The left curves show the distinct effect of ratio of running speed to critical on the lag between high and heavy spots. Right curves mark expected vibration of unit at given speed ratios

duced here are characteristic of a slight rub.

Figure 4 is a conversion of this recording plotted on a polar chart. There it is shown that a plot of successive points results in a small circle, which is progressing in the opposite direction with respect to the rotation of the turbine rotor. The slight rub causing this was not as yet severe enough to produce sub-harmonic vibration.

The circular pattern was produced because of the lag angle existing between the high spot and the heavy spot. The amount of this lag angle would depend on the relationship of the running speed to the critical speed of the unit. The rub will occur at the high spot and thus heat the rotor at this point. This will cause a new heavy spot to develop; since the speed is not changed, the lag angle will remain constant, and the high spot will shift to a new point. The heating of the spindle will now be at another point, thus causing additional change. This will continue until the rub clears.

A similar pattern will develop when water or some other cooling agent is allowed to spray on one side of the rotor, the difference being that successive points will now move in the same direction as the rotor is turning. This is so because now the rotor is being cooled instead of being heated as when a rub occurs.

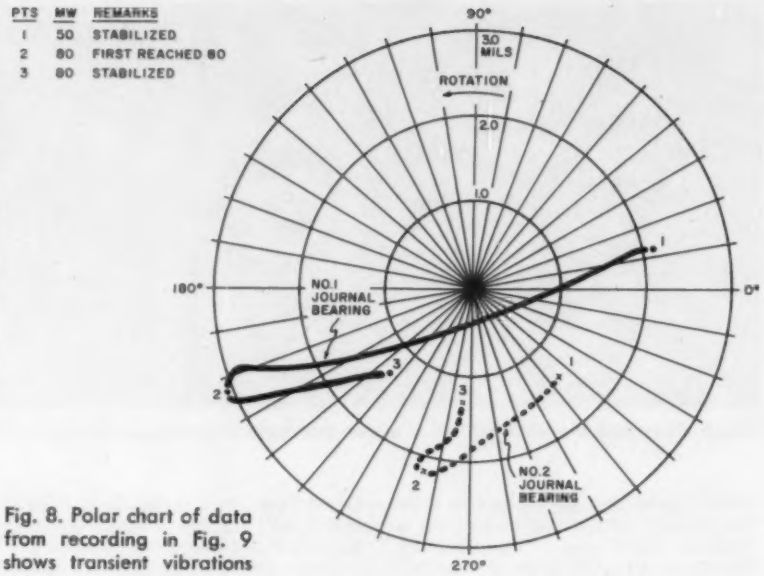


Fig. 8. Polar chart of data from recording in Fig. 9 shows transient vibrations

Use When Balancing

An interesting side light is when one attempts to obtain balancing data on a machine experiencing a slight rub. Quite often those doing this type work feel that readings taken every half hour are sufficient. It can readily be seen here that two successive readings taken a half hour apart would signify an effect of approximately ½ to 1 mil and could be in any particular direction. This, coupled with the true effect of a trial weight, could easily lead to an incorrect balance move.

Data secured with an X and Y-component recorder would immediately eliminate this pitfall by virtue of its multiple readings.

Figures 5 and 6 are a plot and recording obtained on a rotor of a steam turbine of a large midwestern utility. The data were obtained while the rotor was accelerated from 1000 to 3600 rpm. Because of the effects of a critical speed on vibration (see Fig. 7), this now provides an excellent tool for determining the critical speed of the unit. The left curve shows the effects of the relationship between the running speed and the critical speed on the lag angle between the high spot and the heavy spot. The other curve shows the expected buildup when passing through the critical speed.

Thus, referring back to Fig. 5, the critical speed can be determined by constructing a line of tangency to the circle produced from the data, having a perpendicular passing through zero. The intersection of the perpendicular with the tangent line will define the critical speed of the unit.

Another example of data secured by the components recorder is shown in Fig. 8 and 9. This particular machine, also located in the Midwest, had a transient vibration, caused by a condition of non-uniform transferring of heat to and from the spindle. This non-uniform transfer of heat would cause a temporary unbalance by causing the rotor to bend.

Transient vibration was further aggravated by the fact that the degree of unbalance was proportional to the rate of change in the steam conditions imposed upon the spindle. In order to conduct an investigation of a problem of this type, a required great many readings were taken as often as possible, while various steam conditions were varied. This the components recorder performed very satisfactorily. THE END

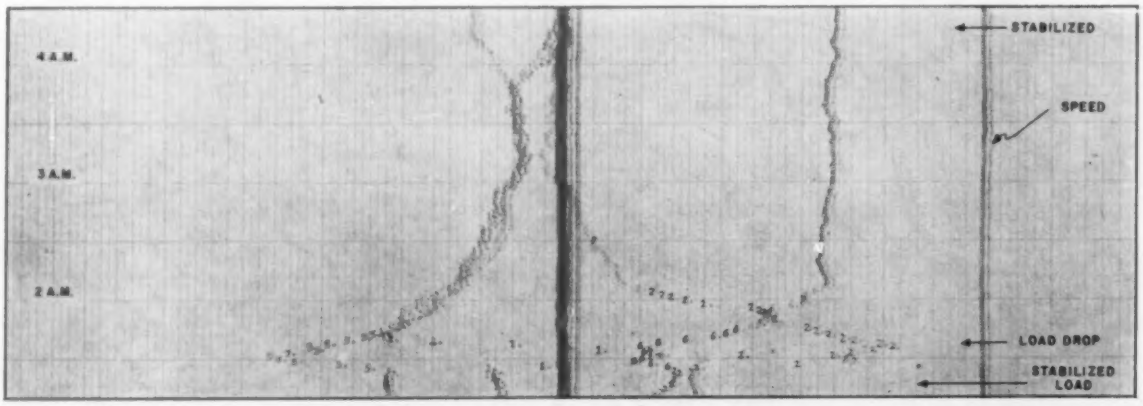


Fig. 9. Recording of transient vibrations experienced with load changes on this turbine generator aided greatly in analysis

Through the use of spherical-tipped pipettes, producing drops of well-defined volume, a small amount of other equipment, and several chemicals in pill form, separately or in combination, it is possible to simplify a number of routine tests while maintaining accuracy that is satisfactory

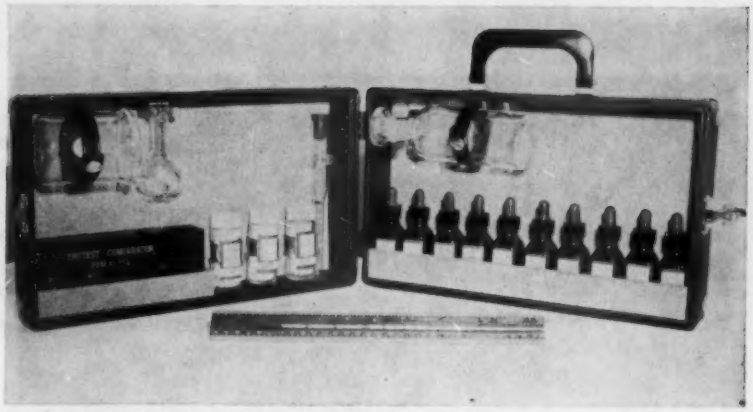


Fig. 1. Compact boiler-water test kit eases performance of many routine tests

Streamlining Boiler-Water Tests

By E. E. WOLFE* and P. N. GALE†

WHERE THE UTMOST precision in testing procedures is required for boiler water treatment control, it is customary to employ "referee" methods of analysis as described in publications of the A.S.T.M. and A.P.H.A.

Goal in these methods is accuracy and therefore such factors as speed, simplicity, and a minimum of equipment are generally of less importance.

Because small plant operation generally does not require extreme precision in analytical methods, there is a growing tendency to substitute simplified but reliable procedures which reduce the time element and eliminate costly and fragile equipment.

One area of simplification in test methods relates to the abandonment of standard burettes and the substitution of dropper pipettes. Titrations are then made by counting the number of drops of the standard titrating solution required to reach the endpoint. The titrant is standardized in terms of value per drop, rather than in the usual manner of value per milliliter.

For this procedure to have any degree of accuracy it is at once obviously necessary to define and understand just what constitutes a "drop." The size of a drop of liquid which will fall from the delivery tip of a pipette will be influenced not only by the surface tension of the liquid itself but also by the interfacial tension between the liquid and the glass.

Number of drops per milliliter delivered from a given pipette will vary sharply between, for example, pure water at room temperature and an alcoholic soap solution. Here we are dealing with liquids of completely different surface tensions.

Also, with any one solution, different pipettes having varying diameters of openings and varying wall thicknesses at the tips, will influence the drop size and consequently the number of drops per milliliter of solution.

Furthermore, the position in which the pipette is held will exert a marked influence. Generally when the drops are released from a pipette held in a vertical position (where the surface area of the glass at the tip will be smallest), the greatest number of drops per milliliter will be obtained. As the position angle departs from the vertical, the size and shape of each drop is altered because of contact with more glass area.

Controlled Volume

With these factors in mind, it is possible to control the titration process and to achieve uniformity in drop size to a successful degree. The test solutions should be at room temperature, and the number of drops equivalent to a milliliter of solution should be counted for each solution prepared, and not assumed that this will be same as with plain water.

Other sources of possible error can also be corrected for. Dropping pipettes are now available which have good uniformity of bore, and which have spherical tips also of fairly-uniform diameters, so that each drop is released from practically the same glass area.

With these factors accounted for we can proceed with confidence that a "drop" is a well-defined volume to which a dependable titrating value can be assigned. A great many tests on a large number of pipettes indicate only negligible variances.

It should be understood that in the employment of drop titration methods for boiler-water testing, no departure from established chemical reactions is involved; the only changes relate to simplifications of test equipment and procedures. For instance, the determination of the chloride content of a sample of boiler water still involves titration with standard silver nitrate solution, in the presence of potassium chromate as the endpoint indicator.

For each kind of test made, it is necessary to have a variety of separate testing solutions such as indicators, preparatory or environmental reagents, and standard titrating solution, as test procedure may require. Therefore, any procedure which can reduce the number of reagents needed per test will speed up the work and give the operator more confidence that he has made the test correctly. As an example, some of the testing reagents can be furnished as dry materials in the form of a pill or tablet containing two or more of the necessary chemicals.

We have successfully adopted these simplifications in the "streamlining" of such tests as the determinations of hydroxides by the barium-chloride method, chlorides by silver nitrate, sulfites by iodide-iodate, soap hardness test, and orthophosphates by molybdate-stannous chloride color development. Other "streamlining" procedures are now under investigation.

Since some reagents are furnished in tablet form, and others in concentrated liquids, small quantities of each are sufficient for a great many tests, and all of the above-mentioned tests, with the exception of phosphates, are made in the same calibrated bottle. All of the necessary materials have been assembled in a small leather-covered carrying case measuring 14 by 8½ by 4 in.

If you would like more information, write The Editor, or jot Chemicals on the postage-paid inquiry card elsewhere in this issue of POWER ENGINEERING. THE END

*Technical Director and †Associate Technical Director, Western Chemical Co

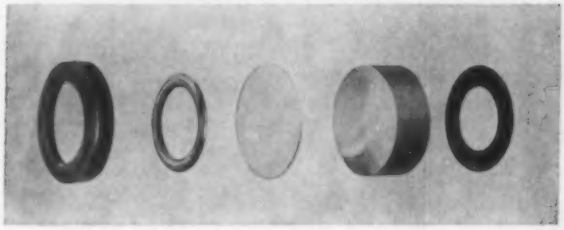


Fig. 1. Welcome aid to boiler maintenance mechanics is this package component replacement kit, shown here in exploded view, for quick and simple maintenance of port-type water gages. From left to right in this picture are the clip ring which holds the assembly together, gasket, mica, glass, and cushion gasket. Next photo shows how this fits in assembly

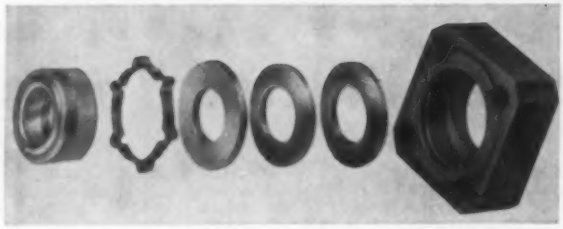


Fig. 2. Cover assembly is shown here in exploded view. From left to right are assembled parts shown in Fig. 1: retaining ring, washer, spring cones, and cover. Retaining ring locates and holds replacement assembly parts in position. With cover in solid contact with gage body, spring cones are compressed to provide necessary load for sealing at the maximum required pressure. Now follow pictures in sequence for proper way to replace a defective glass quickly and easily

Package Components Simplify

Package component replacement can simplify port-type gage maintenance and insure greater service life. By following step-by-step procedure shown on these pages, repairs can be made quickly and effectively immediately after gage has been safely valved off from operating service. Restore gage to service with the drain

Fig. 6. Since the retaining spring will hold the assembly together, removal is simple and the entire unit will come out in one piece. Grasp the cover assembly, as shown here, in position for removing the glass-mica-gasket unit

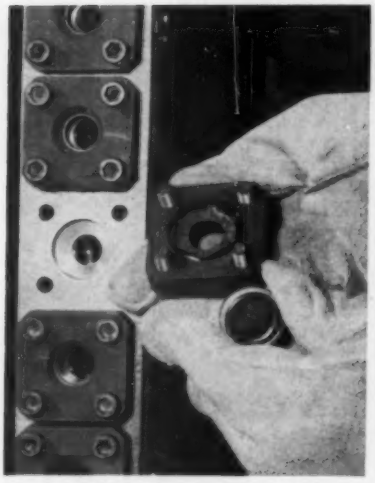


Fig. 7. Glass-mica-gasket assembly is held in one piece in the cover by the retaining spring. On removing old assembly, washer and spring cones are held in one piece by retaining spring. Discard all pieces of old assembly

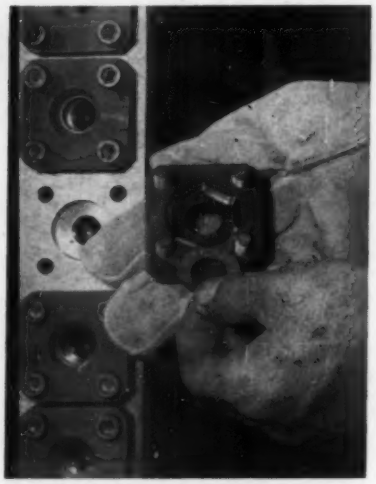


Fig. 8. Now remove cushion gasket. Cleanliness is the by-word here and easily may save having prematurely to replace the unit again. Clean contacting surface of washer and insert new cushion gasket in the cover retaining ring

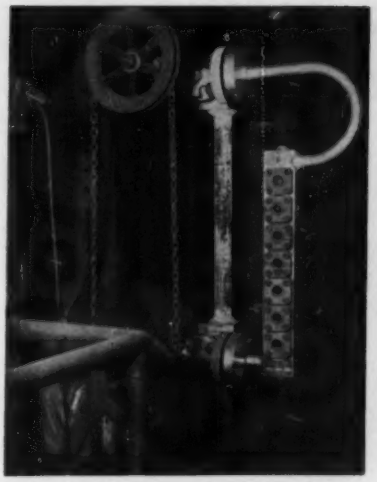


Fig. 3. First step, after notifying the operators that gage will be out of service briefly, is to shut gage valves and gage line valves. With gage isolated from boiler, open the drain line shown here at bottom of the picture

Fig. 4. After gage is isolated from the boiler and all pressure is relieved through the drain line, use an Allen wrench to loosen cap screws of the port to be repaired. Entire assembly will be hot, so gloves are indicated

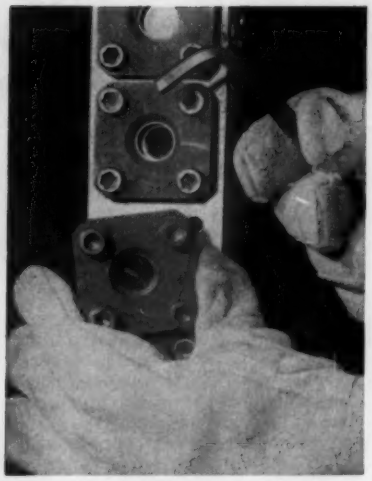


Fig. 5. It is smart to have a bucket or other convenient receptacle handy in which to place cap screws. They are small and you will need them later! When all four cap screws have been loosened, carefully remove the cover

Boiler Port Gage Maintenance

valve fully open and the steam and water valves cracked open. Allow gage to heat up without pressure for approximately five minutes. Gradually bring the gage into full operating service by building up pressure slowly. Finally, close the drain valve tight and fully open all valves between the steam drum and the column

By R. D. NEYER, P.E.
Research Engineer,
Yarnall-Waring Co

Fig. 9. Cleanliness cannot be emphasized too strongly. A small speck, barely visible to the eye, can, if allowed to remain on a sealing surface, cause the gage to leak. Install new glass-mica-gasket assembly in retaining spring

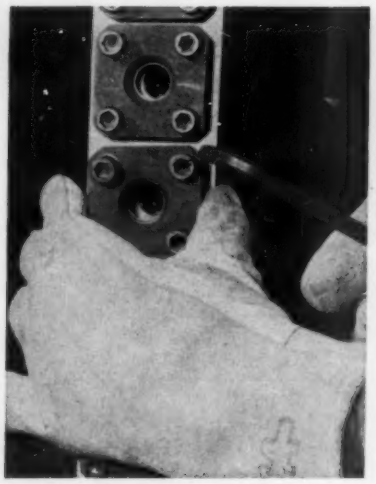


Fig. 10. After making sure that gage body surface is also free of foreign matter, return cover assembly to position. Cap screws should now be tightened snugly without applying force until all have been taken up evenly

Fig. 11. After screws are tight and the cover is in solid contact with gage body, crack line valves and allow gage to heat up for five minutes with drain valve open. Return to service by slowly building up pressure. Close drain

New Static Relays Show Many Advantages

WITH THE announcement of new protective relays completely devoid of moving parts, a new era in relaying was heralded. Two companies in recent weeks have announced they will market static relays, because of a number of advantages these relays have over the conventional electro-mechanical designs.

This is the first change in basic relay design in three to five decades. Allis-Chalmers and General Electric made their production plans public almost simultaneously, each in a different field with their initial offerings.

Allis-Chalmers begins the production of extremely-versatile static over-current relays this summer. Initial output will be reserved for installation in new switchgear.

Many advantages are claimed for the new relay. Since there are no moving parts, there is no wear or vibration. It does not have the difficulties associated with mass and inertia with which relay engineers have had to learn to live. Completely sealed, it is moisture-resistant and dirt-proof. This relay, smaller and lighter, is virtually shock-proof, and requires practically no maintenance, and a minimum of adjustment and testing.

Components employed are those electronic semi-conductors — diodes, transistors, thermistors, varistors — which have proved their extremely high reliability, and conventional circuit elements — resistors, capacitors, transformers. These elements are mounted on a printed circuit, secured to a metal frame, and the complete assembly sealed in epoxy resin. Not only does this procedure produce many of the advantages enumerated above, it makes the unit relatively insensitive to temperature.

Installation of the relay is made by the plug-in method, and replacement thus simplified. Shorting switches for the current transformers are not required. Since power requirements are less than one-half of one watt, only a very small current transformer is required.

But the most important advantage of all, perhaps, is the versatility of this new relay. The complicated relaying problems which are made difficult by the necessity of coördinating conventional relays can be solved quickly and economically through the use of the "building-block" capabilities of this system. Big advantage is that the lag caused by the inertia in the moving parts of conventional relays is cut to almost nothing, and set and re-set times are practically instantaneous.

Rather than targets, small neon lights are used in the new models. This makes the indication of the location of faults practically fool-proof.

Fig. 1. Switchgear comparing new static relays (above) with conventional relays. Only one-third of the space is required

General Electric's new relay, the first of a complete line of static protective relays, is for the protection of high-voltage transmission lines. Operating in conjunction with new transistorized carrier-current equipment, the relays have been extensively field-tested. Designed for high-speed (within 1½ cycles) operation, they offer improved protection to lines by detecting line faults of lower magnitude than previously practical, thus allowing heavier line-loading.

Principle of operation is the comparing of the phase relationships of currents entering and leaving a line section. It is possible to apply the system to existing lines with a minimum of difficulty, and because of its great versatility, it is applicable also to multi-terminal lines.

All of these units are equipped with positive temperature stabilization to provide consistent performance over a wide range of temperatures.

From France comes word of a fault-detecting static device for the protection of power systems, which has been successfully field-tested in three mines. During the year of testing, four incipient faults were detected and eliminated. Because of the extreme danger of explosions in mines, this system is expected to be widely adopted.

It consists of a unit to impress 5000 cps on an electrical network and monitor the resistance to the flow of this carrier current. In the event of significant change, the static relay opens the circuit breakers on the system within 1½ cycles. THE END

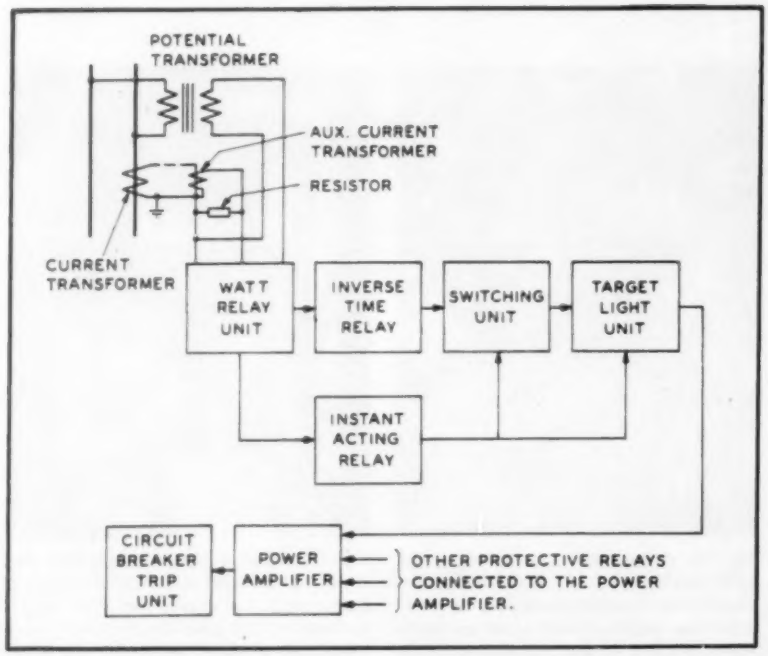


Fig. 2. Schematic illustrating the building-block flexibility of the new relay

Richmond Uses Sewage Plant Effluent As Cooling Tower Make-Up Water

Whether river flows or not, adequate circulating water for additional 30,000-kw turbine generator is assured. Proper treatment of sewage effluent makes it suitable for make-up to cooling tower

By T. C. HOPPE, P.E.*

WHEN THE CITY of Richmond, Indiana, needed a new station for expansion of its electric generating facilities in 1951, it was faced with dwindling resources of ground water and no large surface supply for direct use as cooling water for the size of condenser and turbine proposed. In 1951, the Whitewater River offered the best surface supply available in the vicinity, although the drainage area above the proposed site of the station was only approximately 125 square miles.

Relocation of the site near a more abundant flow was not practical for this municipal project. While the "normal" flow of Whitewater River was sufficient as make-up to a cooling tower system for the first 30,000-kw generating unit, the dependable adequacy for the ultimate station capacity was questionable. Therefore, the only solution was to find another source of supply that could supplement the river during periods of low flows.

Inclination of A. E. Beck, general manager of Richmond's Municipal Electric Lighting and Power Plant, was toward developing a plan which would make use of effluent from the city's sewage treatment plant, located near the site of the proposed new power station. Beck's idea drew support from the city's design engineers, who had sufficient background with other plants using sewage plant effluent to consider its use at Richmond.

For example, the power station at Los Alamos, New Mexico, was designed in the mid-forties to use sewage plant effluent as the only source of make-up water to the cooling tower system; years of operation had shown that the design was practical. Experience at other similar installations indicated that sewage treatment plants employing *complete* treatment could produce an effluent that is usable as cooling water either in a once-through or in an open recirculation system when using acid for the reduction of alkalinity.

In contrast to complete treatment, if a community's sewage has been given only primary treatment, the quality of the effluent is usually so poor that additional treatment is required to render it acceptable for industrial re-use. Unless there is a reason for complete treatment (usually dictated by the health authorities) a community would consider any treatment beyond primary the responsibility of the user. However, even if a community's sewage has been given complete treatment, the quality may not be acceptable for re-use indiscriminately; the ultimate use would dictate whether additional treatment by the industry is required.

Sewage treatment at Richmond, Ind, is complete (with primary and secondary treatment) and incorporates the activated sludge process. The daily flow is about 7,000,000 gal.

The chemical and physical quality of the effluent justified making provi-

* Water Conditioning Consultant, Black & Veatch, Consulting Engineers

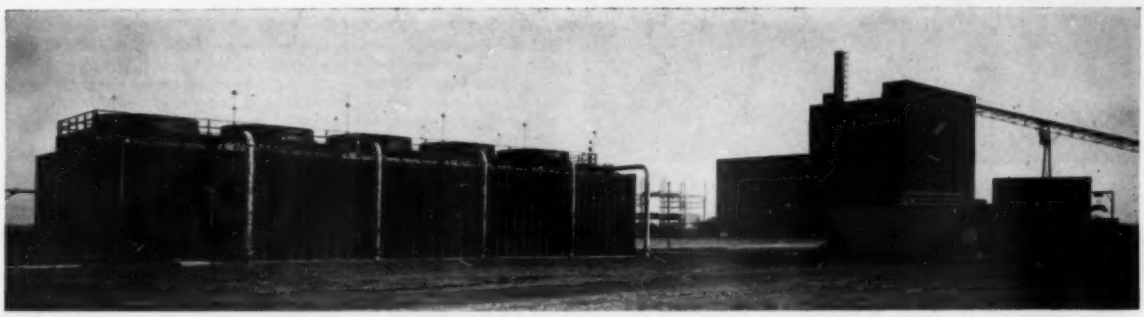


Fig. 1. A dry land plant, Whitewater Valley generating station at Richmond, Ind, gets water from river a mile away. Marley cooling tower has 28,000-gpm capacity. Basin, built to serve future second tower also, stores over 1,500,000 gal

Fig. 2. Discharge of city sewage disposal plant is now about 7,000,000 gal of water a day, which is sufficient water to serve an ultimate 4-unit power plant. Crib intake for power plant is 100 ft upstream from sewage plant outfall

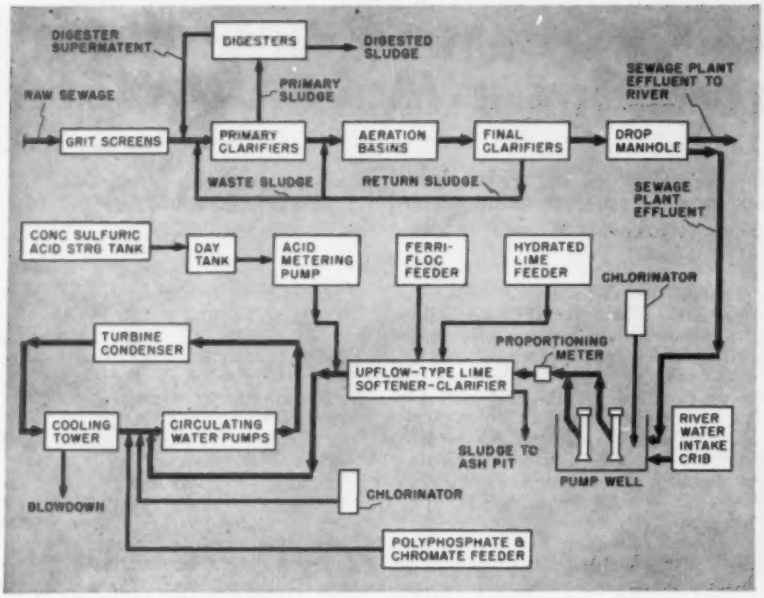


Fig. 3. Cooling water treatment system used at Whitewater Valley Station. Design has proved effective. Problems are mainly in chemical conditioning

Fig. 4. Pump house is about 300 ft from river, has 24-in. line to intake crib. Pump well can receive river water or sewage effluent or a mixture of both

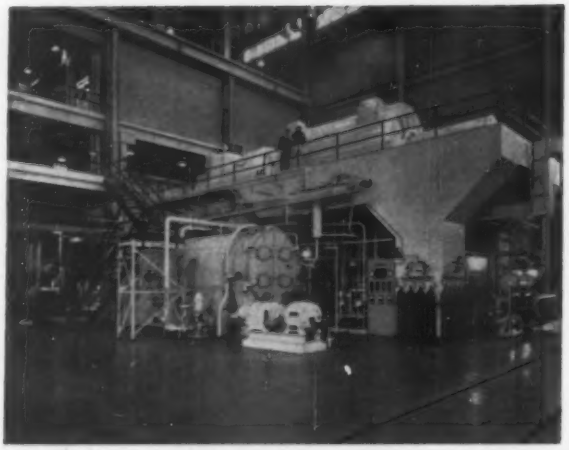


Fig. 5. Turbine generator, first of two, is a G-E unit of 30,000 kw. Steam is supplied at 900 psi and 900 F total temp. Worthington condenser is located beneath turbine

		WHITEWATER RIVER		SEWAGE PLANT EFFLUENT		
		Raw	Treated	Raw	Treated Theoretical Results	Treated Actual Results
Calcium as	$CaCO_3$	229	35	233	35	142
Magnesium as	$CaCO_3$	121	109	148	133	66
Total Hardness as	$CaCO_3$	350	144	381	168	208
Total Alk. as	$CaCO_3$	259	35	292	61	114
Total Phosphate as	$CaCO_3$	0	0	15	0	0
Sulfate as	$CaCO_3$	123	141	97	115	111
Chloride as	$CaCO_3$	18	18	163	163	173
Nitrate as	$CaCO_3$	1	1	29	29	29

Examination of the actual operating results shows that the reduction of alkalinity and hardness in the sewage plant effluent is not as complete as predicted theoretically. However, for make-up to the cooling tower system the quality is still satisfactory. Thus, Richmond, Indiana, has established a firm source of water supply for the cooling tower system regardless of drought condition.

This table gives comparison of chemical quality of the effluent after lime treatment and coagulation when using river water normally and when using sewage effluent in trial

sions for its treatment and use as the only supply of make-up to the cooling tower system, or as supplemental water during periods when the river could not supply 100 per cent of the make-up.

From a standpoint of conditioning the river water before use as make-up, preliminary studies showed that clarification was needed and that lime treatment first with subsequent acidification was more economical than using acid alone for the reduction of alkalinity.

The equipment needed for clarification and subsequent lime treatment would be essentially the same when using either river water or sewage plant effluent individually or as a mixture. However, it is important to remember that the lime treatment process for undiluted sewage plant effluent is difficult to control, and excessive amounts of treatment chemicals are required to counteract the effects of the residual polyphosphates from household detergents. Some of the organic compounds have similar effects. Unless there is an economic reason for alkalinity reduction of the effluent by means of lime, the use of acid for alkalinity reduction instead of lime will eliminate numerous problems of operation.

Intake Crib

In order to provide for the use of either river water or sewage effluent a crib intake was constructed in the river about 100 ft upstream from the sewage plant outfall so that river water could flow by gravity into a pump well. A drop manhole was installed in the outfall line of the sewage plant, with piping to the pump well, so that all or part of the effluent could be diverted for station use. The pump well is equipped with valves so that either river water or sewage plant effluent, or a mixture of the two, can be admitted.

Two vertical, centrifugal, wet pit pumps, each rated at 1600 gpm, deliver the water through one mile of 12-in. steel main to the station for subsequent treatment and use as make-up to the cooling tower system. All other plant requirements such as demineralizers, sanitary facilities, fire protection, and general service are designed to use city water; this arrangement greatly simplifies the identification of piping and the segregation of the contaminated and potable water supplies.

Chlorine feed to the clearwell is provided primarily for the control of biological slimes in the one mile of pipe and not for the oxidation of

ammonia when sewage effluent is used. The chlorinator, with a capacity of 750 lb per day, is interlocked electrically with the pumps to feed chlorine solution only when either of the pumps is in operation.

At the station site the chlorinated water is metered and its flow regulated by a manual flow control valve before discharging into an upflow type, clarifier-softening unit which has a capacity of 1600 gpm.

Chemical treatment at the upflow unit consists of hydrated lime for the reduction of alkalinity and ferric sulfate for coagulation and clarification, each chemical being fed through a dry-type volumetric feeder. Sulfuric acid, for further reduction of alkalinity, is fed in the effluent of the upflow unit through a mercury fluid plunger type of metering pump.

All chemical feeders are interlocked with the flow meter to proportion automatically chemical feed to flow. From the upflow unit the effluent flows by gravity as make-up to the cooling tower system.

Treatment of the circulating water consists of sodium chromate and sodium polyphosphate for control of corrosion and scale. "Shot" chlorination is also provided through a 6000-lb per day chlorinator for control of slime and algae.

Figure 3 shows a flow diagram of the system designed for treatment of make-up water to the cooling towers. To date, the city has not experienced shortage of river water serious enough to require the use of undiluted effluent from the sewage treatment plant. However, trial runs, using 100 per cent sewage effluent, have proved the feasibility of the design and have acquainted the operating personnel with the problems of treatment to be anticipated. Also, this spring, flood waters on the Whitewater River caused a plugging of the station's river intake line. The ability to switch readily from river water to sewage plant effluent for cooling tower make-up water prevented a shut-down and power curtailment.

The problems are mainly in chemical conditioning. When problems with lime treatment become a nuisance while using sewage plant effluent, then the station can operate the upflow unit as a clarifier only without lime. Reduction of alkalinity in the make-up would then be accomplished by an increase in the feed of acid.

Present-day raw sewage from any community is loaded with phosphate and other kinds of detergents, which cause problems in foaming and poor sedimentation even in the sewage treatment plant. The treatment has little effect on the removal of detergents. Further chemical conditioning, by lime treatment, coagulation, and sedimentation, is complexed by these phosphate compounds.

Experience at other stations using sewage plant effluent as make-up to cooling tower systems shows that if no further chemical treatment is required — other than acidification to reduce alkalinity, and shot chlorination — no serious problems are encountered. Experience has also shown that the ammonia in the sewage effluent is not a factor in the corrosion of copper or copper alloy condenser tubes. The ammonia, apparently, is oxidized biologically, as well as lost through aeration at the towers. There appears to be no need to consider the use of chlorine for the oxidation of ammonia.

If the quality of the sewage plant effluent is such that further treatment is required to reduce alkalinity and suspended solids by means of lime coagulant aid, then the treatment process requires meticulous control to produce the desired quality.

Comparison of chemical quality of the effluent after lime treatment and coagulation when using river water normally and when using sewage plant effluent on a trial basis is shown in the table. THE END

This Business of Getting Power Direct from Heat . . . Where Does It Stand Today?

By JOHN C. R. KELLY, Jr *

THERMOELECTRIC power generation is a simple and competitively efficient way to provide power for a number of small and intermediate loads. It is likely to be a useful peaking complement to a central power station. Efficiencies will soon be competitive with all but the most modern large central stations.

Thermoelectric refrigeration is likely to become a significant part of power demand within the next 18 months.

It is necessary to have a basic understanding of the mechanism of thermoelectricity in order to compare it with conventional power generation. Take a block of typical solid containing some free electrons: these electrons can be made to move under the influence of an electric field or under the influence of a thermal field.

If heat is applied to one side of the solid, the electrons will tend to behave much like people. They will rearrange to become somewhat more sparse in the warmer regions of the specimen and somewhat more dense in the colder regions. This leads to an electrical gradient. To take advantage of this electrical gradient, the circuit is closed externally and the electrons flow through the external circuit. (The reverse effect, of pumping heat with electrons, is the basis for thermoelectric refrigeration.)

Contrast this pumping of electrons with heat with the present steam turbine. In the steam turbine, water molecules are pumped with heat but they are not electrically charged and therefore are unable to do any electrical work, only mechanical work which must be transmitted to the generator. Thermoelectricity circumvents the mechanical generator step.

Some of the more efficient power plants today are of 40 per cent thermal efficiency, make up a thermodynamic cycle efficiency of about 45 per cent and a generator efficiency of better than 95 per cent. In a thermoelectric generator we can tolerate much higher temperatures simply because there are no mechanical stresses on the material. This permits cycle efficiencies of 70 per cent or higher.

As for generator efficiency, 40 or 45 per cent is a reasonable forecast. Thermoelectric generators have been built in the range of 1 to 10 watts. Now actual construction is underway on several units extending to the kilowatt range. The calculated efficiency, based upon materials now at hand in the laboratory, is of the order of 13 to 14 per cent. Forecast is that the efficiency of thermoelectric generators in the next 15 or 20 years is unlikely to exceed a practical limit of about 35 per cent.

Following table shows, for heat-rate only, the rather startling difference between the two power conversion systems:

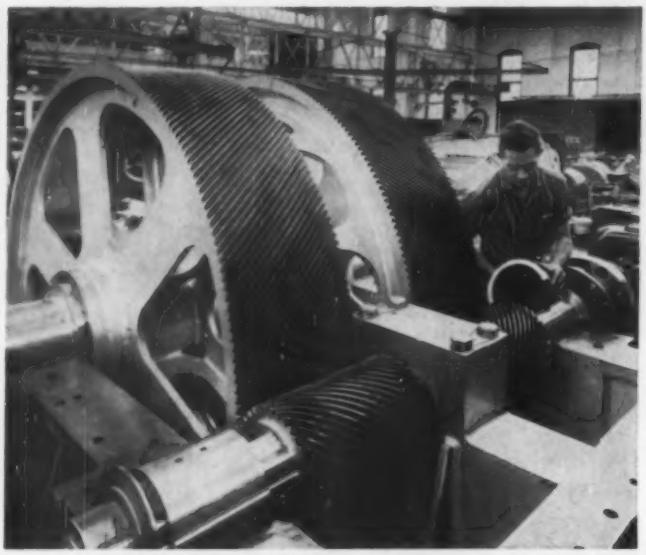
	Thermodynamic Cycle	Generator Efficiency	Overall Thermal
Turbine Generator (today)	45%	95%	42%
Thermoelectric Generator (forecast)	80%	45%	36%

One other factor should be mentioned. The thermoelectric generator is inherently a low-voltage high-current d-c source. Inversion and transforming to multiphase a-c will be a necessary operation.

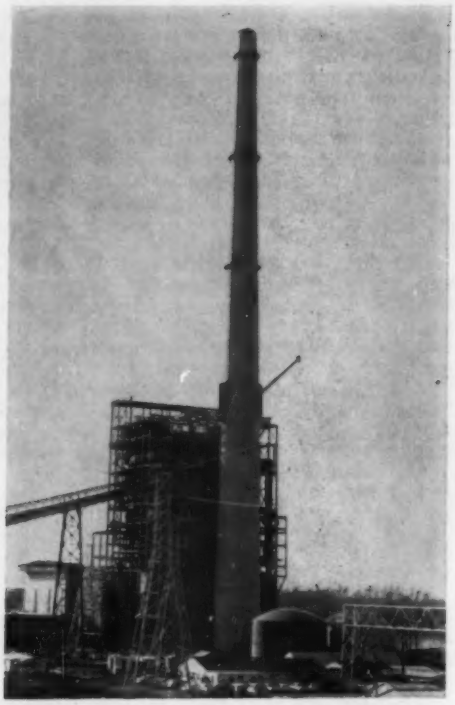
With regard to prime movers the question of power density becomes paramount. In this respect more than in efficiency there is a long period of development ahead since the present values are from 2 to 10 watts per pound. However, values ranging upwards from 100 watts per pound have been calculated for the next generation of devices scheduled for the next two to five years.

* Manager, Technology Dept, Westinghouse Research Laboratories. These remarks are taken from a paper presented at the 1959 American Power Conference

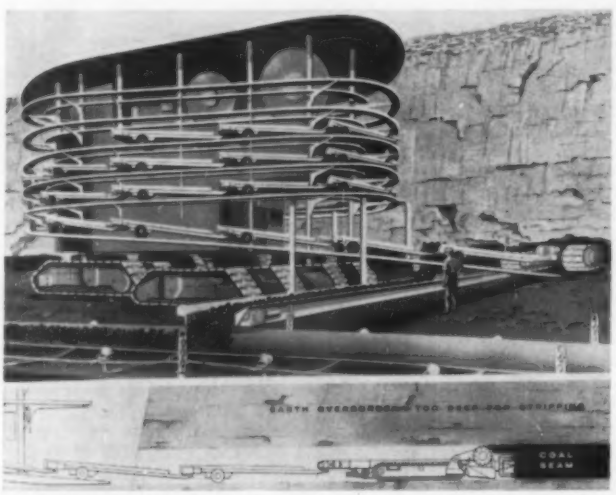
POWER ENGINEERING'S



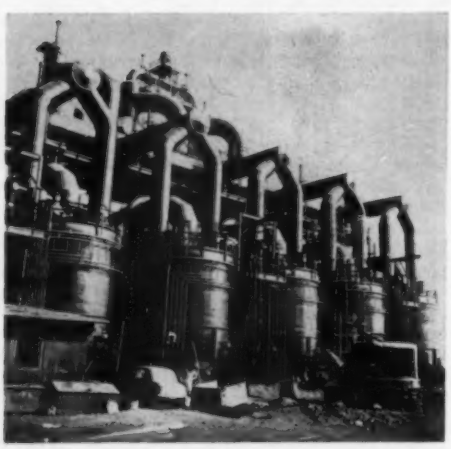
Largest speed increaser in pipeline service is this Westinghouse gearing unit which is now installed at a compressor station of Texas Eastern Transmission Corp. It drives a high speed (6506 rpm), 15,000-hp centrifugal gas compressor, in turn is driven by synchronous motor of 900 rpm



577-ft stack of new Breed Plant of Indiana & Michigan Electric Co near Sullivan, Ind, contains 3873 cu yd of concrete. Height is expected to eliminate most air pollution in the area. Plant will have a single 450,000-kw generator



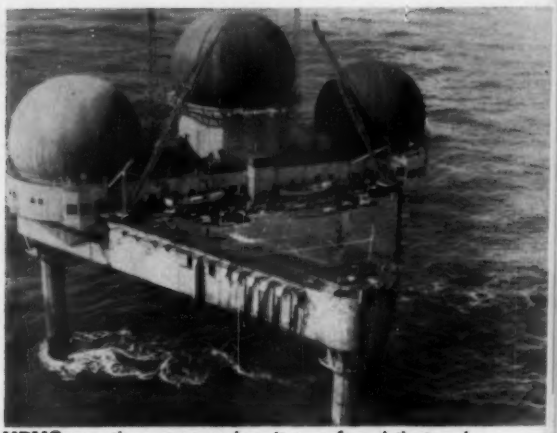
Push-button mining will result from this machine, being built by Joy Mfg Co for Peabody Coal Co. Electronically controlled, it is designed to recover coal too deep for stripping, and which cannot be mined economically with present equipment. It will eliminate the costly steps of roof support and underground ventilation



Blast furnaces gas from huge plant of Tata Iron & Steel Co at Jamshedpur, India, is cleaned by six 2-unit electrostatic precipitators installed by Research-Cottrell. Set cleans 360,000 cfm total gas at 105 F with 96.7 per cent efficiency

NEWS REEL

Monorail, rated by many experts as an answer to the mass transportation problem, comes to town in Seattle. The city's Fifth Ave and Pine St will look like this when monorail system designed by Lockheed Aircraft Corp is completed to serve Seattle's Century 21 Exposition, which opens in 1961. Airtrains will travel at 60 mph



UPVC was the answer when it was found that galvanic corrosion had attacked the alloy piping of cooling system for the diesel generators of Texas Tower No. 2, radar island off Cape Cod. All piping was changed to unplasticized polyvinyl chloride

Scroll case for one of 12 reversible pump-turbines for the New York State Power Authority's Tuscarora plant is here being assembled to the stay ring. Scene is Allis-Chalmers' West Allis (Wis) Works. Huge scroll case has an 18-ft diameter inlet and measures 56 ft across. Each turbine in reverse rotation will be a 25,000-kva generating unit

Giant wrought iron wedges made by A. M. Byers Co are slated for mechanical shielding functions aboard a nuclear-powered vessel. Iron was torch-cut to required size, heated to 2500 F and forged

Industrial Power Plant Accounting

By JOHN S. COLE, P.E.

Earlier articles in this series explained how to set up effective records to cut operating costs and support departmental charges. This month Mr. Cole concludes by telling how to derive . . . . . .

Accurate Budgets from Good Cost Data

FROM TABLES II and III shown in the article that appeared in the June issue of POWER ENGINEERING, the table in this article is derived to arrive at an equitable price to charge operating sections for the utilities they use.

Columns 1 and 2 show unit costs of generation and distribution. Column 3 shows total cost of generation and distribution. Column 4 shows an equitable price to be charged the operating sections for the services they use. Column 5 lists quantities of each utility sold to the operating sections. Column 6 shows the amount recovered to the utilities section from sale of utilities to the using sections.

Recovery from the sale of utilities is $1,519,935, a profit difference of $32,665 to the power section. This sum can be used to cover unforeseen contingencies in maintenance, or can be returned to the purchasing section as a dividend at the end of each fiscal year.

Data such as that presented in articles in this series, which has been accumulated to compute the operating budget of a power department, can also be of invaluable assistance in supporting any proposals for improving the operation of that department for decreasing operating costs, or for increasing facilities which the power department controls and distributes.

Peak Periods Are Changing

Until quite recently, the power peaks for industrial and utility plants coincided with peak steam demands. These periods of high steam and power demands occurred during the winter months when steam was required for heating, and the power was needed for lighting on the dark winter days.

With the wide use of air conditioning for both product control and personal comfort, the picture has changed completely. Now the winter months give a peak in the steam demand, and the summer months are showing a peak in the power demand.

As a plant installs air conditioning, the power engineer is given an opportunity to level out his steam requirements, thus getting best possible year round efficiency from his boilers. Quite often, with proper balance in his power generation, he can get his air conditioning power requirements with little or no increase in fuel consumption.

If properly presented to top plant management, such a proposition will frequently sell itself. To present such a proposal properly, the power engineer must have adequate and authentic figures to back him up.

In air conditioning a plant, two general methods can be used. First, individual packaged units can be installed in the areas; or, second, the air conditioning units can be supplied from a central-type unit, circulating chilled water to the units.

If packaged-type units are used, they could be either air-cooled or water-cooled. If of either type, they

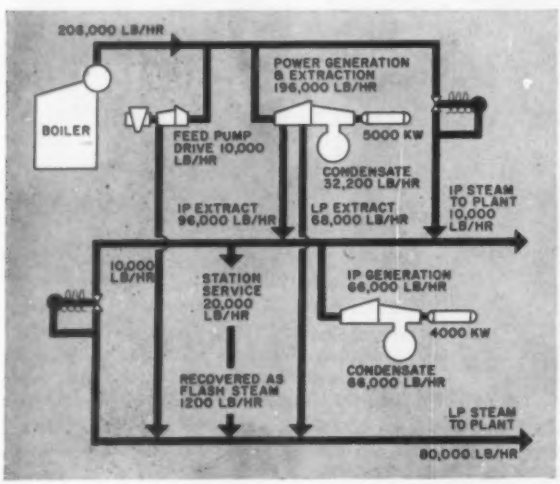


Fig. 1. Typical winter heat balance is basis for other three balance calculations of possible air conditioning schemes

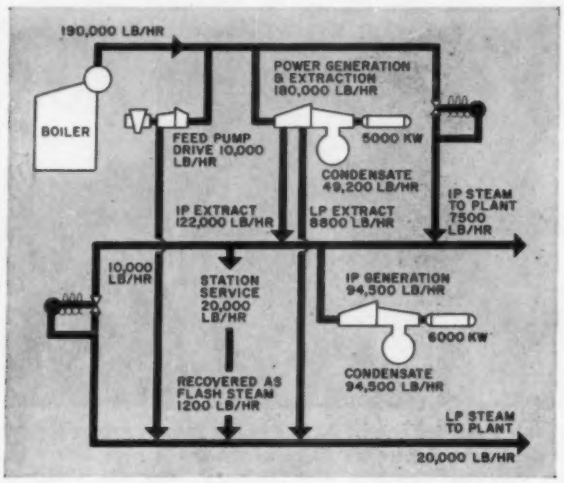


Fig. 2. Summer heat balance for same plant in Fig. 1. Note volume of condensed steam available for air conditioning

Table shows a good, logical method of arriving at an equitable unit price to charge operating sections for utilities

Utility	1. Generating cost	2. Distribution cost	3. Total cost	4. Sale price	5. Units sold	6. Plant recovery	
H. P. Steam	$0.904	$ —	$ —	$ —	—	$ —	Internal use only
I. P. Steam	1.08	0.044	1.124	1.25	106,000,000	132,500	Units, 1000 lbs
L. P. Steam	.925	.109	1.034	1.15	270,000,000	310,500	Units, 1000 lbs
In-plant Power	.0175	.0014	.0189	.021	34,400,000	722,400	Units, kw-hr
Compressed Air	.163	.016	.179	.20	388,000,000	77,600	Units, 1000 cu. ft.
Treated Water	.119	.06	.179	.25	504,000,000	128,000	Units, 1000 gal.
Purchased Water	—	.332	.332	Cost	270,000,000	89,400	Units, 1000 gal.
Purchased Power	—	.0247	.0247	Cost	3,750,000	92,200	Units, kw-hr
						$1,552,600, Total recovery	

will further increase power requirements at peak seasons. If of the water-cooled type, they would require the use of a cooling tower to prevent excessive water usage. Here, again, the requirement for water would further increase demand at peak seasons.

In most cases, the installation of packaged-type units represents the lowest first cost. Maintenance and operating costs increase rapidly, however, and the useful life of these units is considerably less than that of a central station-type installation. First cost of a central station-type unit is, in general, higher than for a similar tonnage in packaged units, but operating and maintenance costs are considerably less. In addition to this fact, if the prime mover power can result in a reduced power cost and better plant operation, then the installation easily can be justified.

Consider a plant with winter operating conditions as shown in Fig. 1, and with summer operating conditions as shown in Fig. 2. Note that the power demand is *increased* during the summer; that plant demand for intermediate-pressure steam is *decreased* by 25 per cent, and the demand for low-pressure steam has *decreased* by 75 per cent. Also note that the steam to the condensers has *increased* by 57 per cent.

By introducing a turbine-driven central station-type air conditioning unit in the intermediate steam system, some of this slack can be taken up. Refer now to Fig. 3. With no increase in steam output of the high pressure boilers, 500 tons of air conditioning refrigeration have been picked up. All steam required to drive the unit comes from that which was formerly condensed.

Another 500 tons of air conditioning refrigeration could be obtained by installing a unit to use extracted low pressure steam. This would also take otherwise condensed steam from the high pressure unit condensers and would require no increase in steam generation. Conditions obtained from this latter installation would be as shown in Fig. 4.

It would be impossible to predict any possible savings which such installations would give unless the power engineer had a very complete and accurate set of figures on which to base his reasoning, and with which to back up his arguments.

By training, an engineer is generally very thorough in all his work. He therefore can, and often does, produce in volume all the facts and figures necessary to support his budget or back up his request for new or replacement facilities. Frequently, the very thoroughness of preparation and the volume of figures produced, together with the complexity of diagrams, charts and tabulations, so overwhelm non-technical top management that their purpose is defeated.

It is necessary to accumulate all the data, work up charts, and make diagrams and tabulations. This information must then be boiled down and concentrated so that the essential facts, and only those facts, are made up in final form for presentation to obtain management decisions.

In order to accumulate and evaluate the mass of data necessary for use in preparing budgetary and other presentations to top management, and for use in computing operating costs, it is mandatory that the engineer get the closest possible coöperation of all other sections of the plant.

He must work closely with the supervision of the operating sections in order to get first-hand information on probable process changes and changing utilities demands.

He must work closely with timekeeping, purchasing and accounting so the charges for labor, material, overhead and fixed charges are properly allocated. It is not possible to make any good budget, or to fix costs of production of utilities, unless all charges are properly distributed.

In general, the plant accounting section is best fitted to accumulate the various charges which go to make up the costs of producing and distributing utilities. The engineer and the plant accountants must take every care to see that the split-up of the charges between generation and

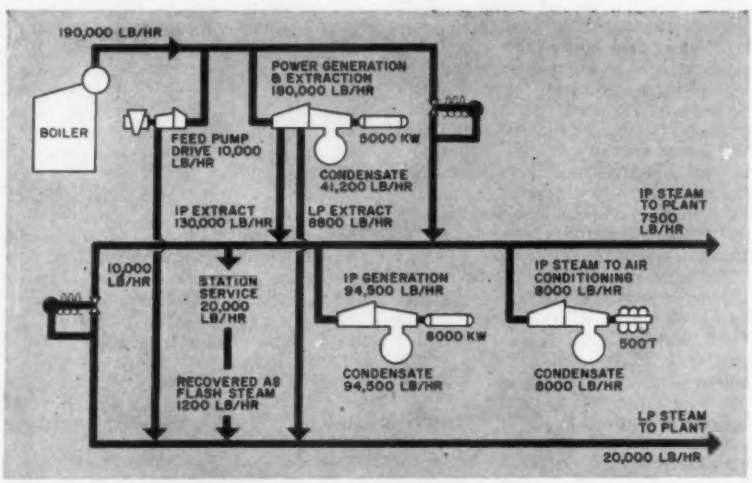


Fig. 3. Here IP turbine drives air conditioning compressor without generating additional steam. 500 tons of air conditioning refrigeration have been added

Want Reprints?

This series of four articles on industrial power plant accounting is being reprinted in its entirety. If you would like a copy, write the editors on your letterhead or jot "Accounting Series" on one of the return postcards in this issue.

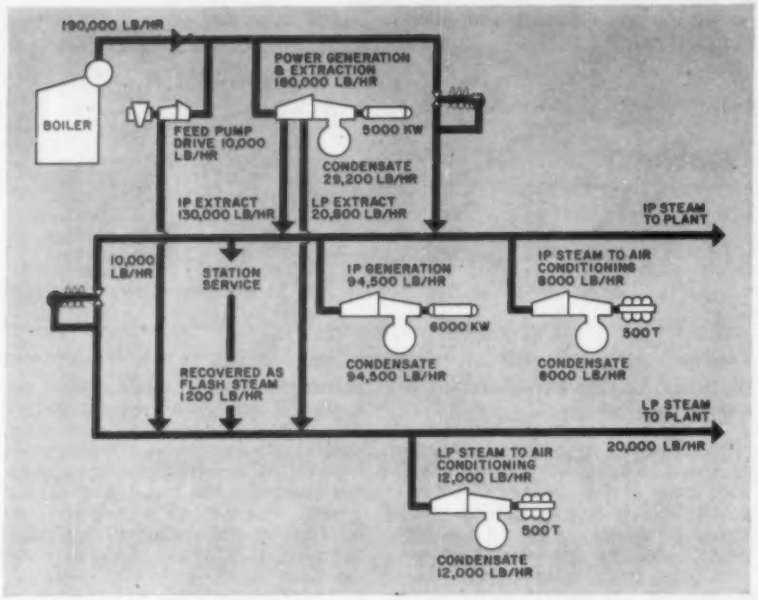


Fig. 4. Another scheme showing how both IP and LP turbines can drive compressors for 1000 "free" tons air conditioning. No increase in steam generation is needed

distribution are accurately made, to prevent overloading of either generation or distribution, and thus obtain a false picture of costs.

In the same way, great care must be taken to insure that charges of all kinds are correctly assigned to the various utilities.

Generally, purchase requisitions for supplies and materials originate in the power department. Thus, it becomes the responsibility of the department to see that the cost of these supplies and materials is charged against the utility for which they are to be used, and also to see that the charges are allocated properly to generation or distribution.

Same responsibility exists in making up the daily timesheets for proper distribution of operating and maintenance labor. Since these labor charges amount to about 16 per cent of the cost of operating the utilities section, any distortion of them by improper allocation will result in a false cost picture and thus make the results of no value. Since overhead charges depend on total labor charges, any distortion of labor charges will double the amount of error when overhead charges are added.

There are several ways in which fixed charges may be divided between generation and distribution. Probably the best and most equitable way is on the basis of the ratios of first costs. Since equipment is depreciated on the basis of its first cost, by lumping all power department first costs and using that as a denominator, with first cost of equipment used for generating and distributing a particular utility as a numerator, a percentage will be obtained which can be used to derive the portion of fixed charges to be applied to each utility.

The engineer should arrange with the accounting section to make up his cost sheet each month. With this, he then can keep a close check on his operating costs and take corrective action when any of these costs get out of line. With the monthly utility cost sheet, accounting should also furnish a performance sheet which shows in detail how actual operating costs compare with the money budgeted for the power department.

With these two records, computed and supplied by an agency outside his department, the engineer has a good instrument with which to check departmental performance. THE END

Fairless Works Burns Three Fuels Simultaneously

ONE OF the many problems existing in industry today is the efficient utilization of so-called "waste fuel." Fuel, regardless of where it originates, should never be considered as waste fuel. A million Btu of heat energy is worth exactly the same amount of money, regardless of its source, and should be used just as efficiently as possible at all times. So said W. O. Barnett, general foreman of U. S. Steel's Fairless Works Utilities Department, before the American Power Conference recently.

At Fairless Works there are three fuels available: blast furnace gas, coke oven gas, and residual fuel oil. Blast furnace gas is a by-product of the iron-making operation and has a value of 95 to 100 Btu per cu ft. Coke oven gas is a by-product of the coke-making operation and has a value of 560 Btu per cu ft. Residual fuel oil is a purchased stand-by fuel with a value of 151,000 Btu per gallon. In using these three fuels in one plant, the problem is to be able to interchange fuels as they are available on a Btu basis.

One of several boilers at Fairless, designed to fire all three fuels as they are available, is a standard two-drum single pass circulation boiler with a design capacity of 300,000 lb per hr at 885 psi and 900 F. This boiler is equipped with separate burners for each of the three fuels. To accomplish efficient by-product fuel firing on an availability basis and still maintain full power station output, a complex control system is required. Boiler controls are entirely pneumatic, operating on a 5 to 25-psi signal for control, and 40-psi air supply for control drive units.

Perhaps the most unusual feature of the control system is the fuel flow sequence. Fuel preference is blast furnace gas, then coke oven gas, and finally residual fuel oil. A pneumatic signal is transmitted from the plant master to the individual boiler master station. This control station controls fuel to the boiler and maintains steam output as dictated by the plant master control station.

With blast furnace gas being the primary fuel, blast furnace gas control receives this signal first. Signal is transmitted through a series of relays and limiting devices to a manual-automatic control station. From there, a common signal is transmitted, unless biased, to three blast furnace gas burners. Each burner has separate fuel and air meters that transmit a pneumatic signal to a ratio relay. This relay maintains proper fuel-air ratio to each burner at all times.

If for any reason the blast furnace gas is inadequate for steam demand, the sequence relay will transmit that part of the signal not satisfied to the coke oven gas control system. This is accomplished with a sequence relay which compares the signal from the total blast furnace gas meter against output signal from the boiler master control. An imbalance between these signals will be transmitted through various relays to the coke oven gas control valves, causing them to open until the signals are again in balance.

Residual fuel oil control functions in the same manner as the coke oven gas control.

This unique plant is the result of close coöperation between owner and equipment manufacturer, cutting costs from an original estimate of $350,000 to an actual installed cost of only $150,000. Fourteen-foot platform uses available space, minimizes h-p piping

First U. S. Planetary Gear Installation Cuts Space Requirements and Costs

By **THEODORE A. PIERSON III*** and **VINCENT S. WAGNER†**

UNIQUE FEATURES resulted from planned expansion of the Homasote Co power plant at Trenton, N. J. These include a non-condensing turbine driving a 1250-kw generator through a planetary reducing gear, all mounted on a steel platform 14 ft above the boiler room floor, and an interesting system for control of load under both normal and emergency conditions.

Previous to the installation of this turbine-generator unit, Homasote, which manufactures high-density fibre insulating board, had installed a 450-psig, 550-F boiler, but had operated it at 135 psig for process steam only.

Coöperative study of heat balances and power supplies indicated that the planned purchase of a duplicate boiler and a condensing extraction turbine was unnecessary and extremely expansive. Instead, it was proposed to bring the existing high-pressure boiler up to its rated pressure and temperature and to acquire a back-pressure turbine to exhaust at process steam pressure.

This new plan would provide electricity at practically no operating cost. Centralized relocation of Scotch marine boilers with automatic controls and proper induced draft would provide increased total steam capacity.

This plan was based on Homasote's requirements for uniform steam 24 hours a day during the work week and a steady electrical supply during the same period. The rating of the proposed turbine was tied in to use the maximum amount of steam capability of the high-pressure boiler.

Use of a back-pressure turbine eliminated the need for new construction to house condensing equipment.

But space was still at a premium in the existing boiler house. The conventional turbine-reducing gear-generator unit with a horizontally displaced, parallel-axis reducing gear was not applicable since it would take up too much space. A two-pole direct-driven generator was also scratched off because it could not be supplied at any rating lower than 2000 kw. Headroom and difficult installation problems decided against the use of an in-line vertically-displaced reduction gear.

To fit such a unit into available space use of a De Laval-Stoeckicht planetary gear was proposed. This lightweight gear, rated at 2800 hp, compresses highly-efficient power transmission into a minimum amount of space.

Not content with saving space at ground level, the owner and the manufacturer decided to go one step further. Realizing the advantages of in-line arrangement in centralized weight distribution, they came up with the idea of raising the turbine-generator unit 14 ft above floor level on a basically simple, independent steel structure. The structure consists of 14-ft H-beams supporting a steel platform.

Short steam lines, which were possible from the high elevation of the turbine inlet to the boiler adjacent to the turbine, saved the cost of high-pressure piping, and kept installation cost to a bare minimum. Because of the simplified installation it was possible to put the generator into the existing plant with only the maintenance personnel of the plant being actively engaged.

Into the space beneath the platform, it was possible to fit the planned complete control center for the operation of all the boilers and auxiliaries and the turbine-generator controls.

The turbine is rated at 440 psig and 550-F inlet temperature. It exhausts at 135-psig back pressure. The planetary gear reduces the 4600-rpm turbine speed to 1200 rpm to drive the 4160-v, 60-cycle, three-phase generator. With a rating of 1250 kw at 80 per cent power factor, this generator is of the open drip-proof type, manufactured by General Electric. A pump is attached to the turbine shaft and rotates at full turbine speed to furnish lubrication for the turbine, planetary gear, and generator bearings.

Operating governor in normal weekday service is a back-pressure control. Back-pressure is set to fulfill the basic function of the unit — to maintain a constant process-steam pressure while producing as much electrical energy as possible.

Whereas the former system had supplied all steam at 135 psig, the heat balance showed the advantage of using 3 levels, 450 psig to the turbine, 135 psig to the process, and 35 psig for plant heating. This step allowed the incorporation of a turbine-driven boiler-feed pump. THE END

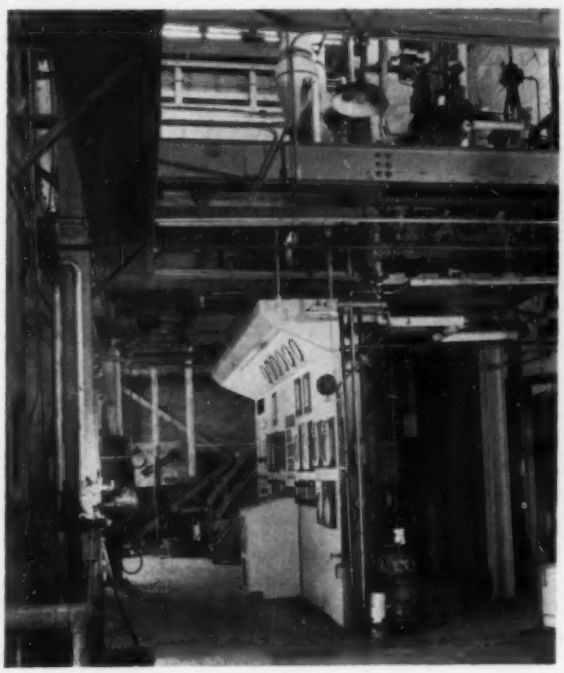
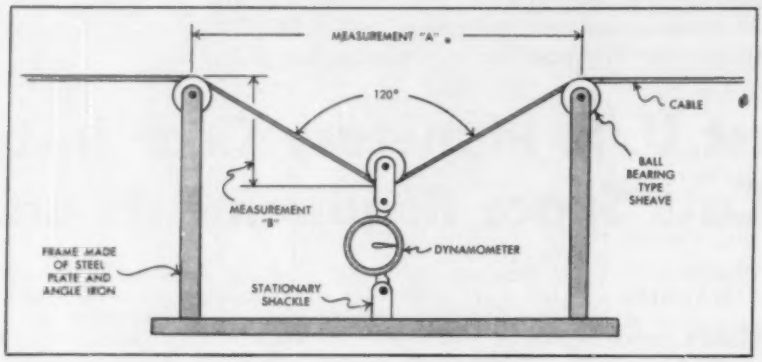


Fig. 1. Control center for boilers, turbine-generator and electrical switchgear. Unit may be seen on its steel base at the top of the picture. Quiet operation and low vibration of the unit permit this arrangement

*Homasote Company, and †De Laval Steam Turbine Co



How to Measure with Dynamometers

You can't beat the versatility of a portable dynamometer for measuring tension, weight, torque and compression. It's a valuable tool for the power engineer. This article shows some of the many applications of this instrument in the power field

By RALPH R. DILLON *

POWER AND STRENGTH are like cash in a bank account. They are assets to be used, drawn upon, and relied upon. However, if power and strength are unknown quantities, they are of little more value than a bank account with no records, no bank book, and no statements.

If such factors as tension, weight, torque, and compression are to be put to work, or depended upon to safeguard life and equipment, they have to be known. That is, their values have to be measured.

There are several ways to caliper some of these unknowns. But there is one simple, inexpensive way to measure them all, and that is with a traction type DYNAMOMETER.

Some of the latest dynamometers approach the accuracy and reliability of precision knife-edge platform scales. People who visit the assembly department here at our plant, for instance, are amazed to see the battery of testing instruments that our craftsmen use in calibrating dynamometers. After seeing a dynamometer withstand years of battering around on the end of a chain hoist, it seems strange to see heavy-duty industrial instruments calibrated with such meticulous watchmaker workmanship.

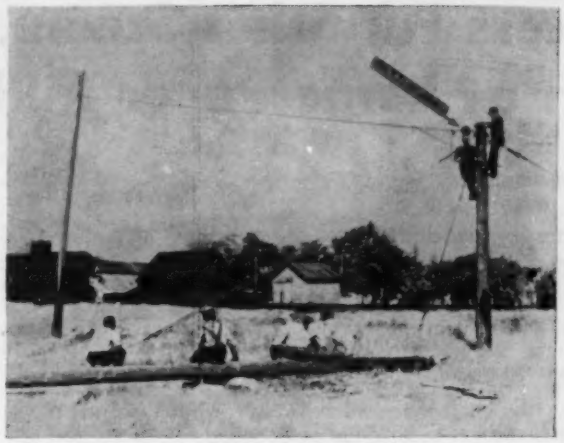
Dynamometers combine accuracy with compactness and ruggedness. They don't require kid-glove handling. They are inexpensive and extremely versatile. Most importantly perhaps, a dynamometer is portable.

*Chief Engineer, W. C. Dillon and Co

1 Utility company saves money by reclaiming short lengths of conductor; butt-welds pieces together. Dynamometer is used to determine strength of welds, for reuse of wire

2 Popular use of dynamometers is in crane service. Functions performed are weighing of lifted load, and prevention of crane damage by overload. Acts as a safety device

3 Here a dynamometer provides a simple method for testing deflection in a stack of high-tension insulators. Photo courtesy of I-T-E Circuit Breaker Co. Aids in design of stack



4 Utility linemen use dynamometer and ratchet hoist to test strength of pole on left. Anchored pole at right is used for attachment of test equipment, which is easy to use

5 Linemen measure tension in line conductor, with dynamometer, and without disconnecting wire. Come-along and snatch-blocks are also used for this quick, simple test

Unwieldy objects don't have to be taken to it; it can be taken right to the job.

A power pole, for instance, is a long, cumbersome object that is extremely difficult to get onto a platform scale. But, a crane or lift truck equipped with a dynamometer can lift it and weigh it in a few seconds. In fact, an object can be weighed in exactly zero seconds if the weighing operation is made an integral part of the loading operation.

Many power companies weigh poles, transformers, cable and other items, as they are being loaded on their trucks — to prevent heavy fines levied against overloaded vehicles.

A dynamometer can serve a myriad of purposes out in the field, too. Half-used reels of cable can be weighed to determine the amount of wire left on the reels. When cable is being strung, the dynamometer can be used to measure and equalize tension. Dynamometers can be used to check the static strength of telephone poles, even the holding power of land anchors.

The many uses of dynamometers are too varied to permit their full description here, but a brief sampling below gives a hint of their versatility:

Measuring pulling power of engines
Checking joints on conveyors
Testing cable or chain slings
Checking torque of gear-reducers
Crane-overload prevention
Measuring tension in a moving line
Aligning turbine generators
Checking safety belts
Testing armature binding wire
Tests of hoisting apparatus
Insulator stack deflection tests
Checking torque of motors
Testing strength of products

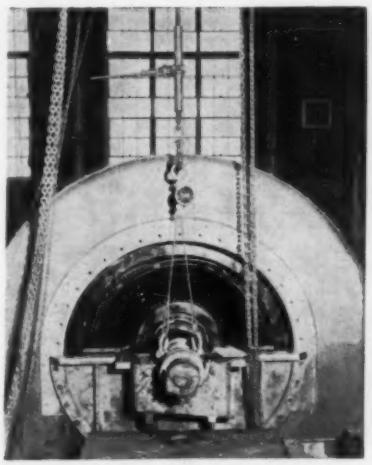
Dynamometers, of course, are no more restricted to the electric power industry than are telephones or electric lights, but they can be just as useful. Their great versatility puts them to work as safety devices, time-savers, and money-savers, in all industries — for shop, laboratory, or field applications.

Aircraft manufacturers use them to measure the thrust of jet engines. Air and sea cargo-carriers use them to prevent weight imbalance during loading. The Navy uses them on aircraft carriers to test the holding power of arresting cables. Foundries use them to keep a constant check of the molten metal in a ladle, to keep from making a costly, incomplete pour.

A dynamometer is truly the universal measuring instrument. It offers a practical solution where accuracy, low cost, and portability are required.

Editor's note: Although dynamometers have been in use for years, their full potential is not realized by many power engineers. As the article states, only a limited number of applications are referred to.

Like other versatile instruments, or tools, the dynamometer can be of greatest value to the operating engineer if he seeks new and wider use for it. Very few tools serve as many purposes as dynamometers. THE END



6 Time-saving method of aligning turbine rotor is demonstrated here. Shaft is raised by crane, until dynamometer indicates desired load to be carried on bearing surfaces of turbine

7 Prevention of damage to sluiceway equipment is assured by means of dynamometer attachment to cable. Installation is on spillway gates at Chief Joseph Dam, in Washington

WOULD YOU LIKE TEAR SHEETS?

Readers who want tear sheets of any article appearing in the issue for their personal file may obtain them by indicating the item desired on one of the post cards appearing in this issue—Editors.

New Recovery Process Furnishes Steam, Stops Pollution at Large Paper Mill

Stream pollution, resulting from loss of vital chemicals used in paper-making, plagued this utility-paper company. Research teamwork between company and equipment manufacturer solved the problem, recovered chemicals; will furnish large quantity of steam

LATEST MILESTONE in the unrelenting drive on the part of industry to clean up the nation's streams was unveiled recently in Wisconsin Rapids, Wis. Known as the W-P Recovery Process, the new installation is a joint research and development project of Consolidated Water Power and Paper Co and Western Precipitation Corp.

Developed for the pulp and paper industry, the process recovers valuable chemicals used in the manufacture of paper, produces steam for process and power as a by-product, and reduces bacteriological oxygen demand imposed on neighboring streams by burning chemical effluents that, hitherto, had been dumped.

Chemical recovery boilers are no innovation to the paper industry; kraft mills have long had such installations. However, only spent kraft-type liquors lend themselves to chemical recovery by combustion without additional treatment, and kraft liquors represent a minor portion of all paper mill liquor effluent.

Greatest value of the new W-P Process lies in the fact that, in combination with sodium sulfide by rapid oxidation with air, any sodium-base sulfite liquor reclaimed from the pulping process can be converted to a kraft-type liquor. Flow diagram of the process is shown in Fig. 1. This liquor is then concentrated in evaporators to a medium composed 65 per cent of solids. Solids consist of chemicals remaining in the spent liquor, and the lignins, sugars, and tannins previously removed from wood in the pulping process. Concentrated liquor is then sent to a recovery boiler as fuel, steam is produced for further process, and chemicals are recovered as smelt.

Process Steam Is By-Product

It is at the furnace that major economies are effected through the production of high-pressure steam, Fig. 2. Since this first section of the installation was operated originally as a pilot plant, no boiler was installed, and a second air heater was incorporated in design in lieu of a boiler to dissipate heat of furnace gases. (A new furnace and boiler, which is to be added as the plant is

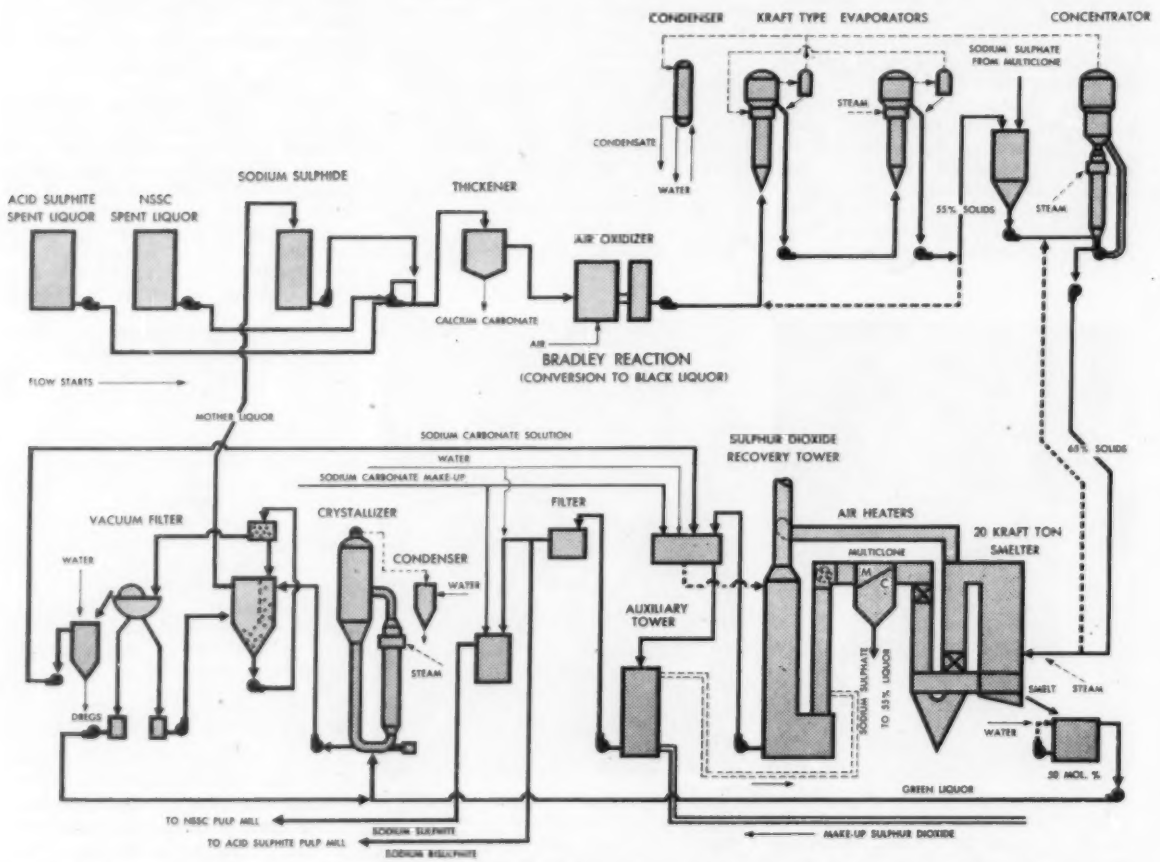


Fig. 1. Flow diagram of W-P Recovery Process at Consolidated Water Power & Paper Co. Recovery boiler is at lower right

expanded, will be able to deliver 75,000 lb steam per hr from the volume of liquor presently to be treated.)

Exit gas at 1800 F is diluted with air to 1200 F. This then goes to the first in-line air heater which will ultimately be replaced with a steam generator and economizer taking the 1800 F gas without dilution. From here the gases are discharged at 550 F to what will ultimately be the conventional steam generator gas-to-air-type air heater. Outlet gas temperatures with this air heater are maintained at 300 F. Developers of the process claim that this is the first instance in the United States in which it has been possible to maintain exit temperatures as low as this with a gas-to-air heater on a recovery furnace.

Standard recovery practice uses a boiler, then an economizer or an air heater, to recover the heat for steam generation, lowering the gas to a temperature of from 750 to 450 F. Ordinarily the exit gases are then contacted with partially evaporated liquor which cools the gases and completes the evaporation of the liquor to firing concentration. The gases then leave this process at 300 F to go to an electrical precipitator or, if a Venturi scrubber is being used as a direct contact evaporator, they go directly to the stack at saturation.

In the new system all of the evaporation will be done with multiple effect economy, say, 5 to 6 lb of water evaporated per lb of steam used. Developers of the process claim that the combined use of the air heater for a final heat trap and a steam operated forced circulation concentrator in multiple effect for a final concentration of the liquor will show a 10 per cent improvement in net steam production. This combination can replace the direct contact evaporator usually used in this country.

Conditions under which air heaters operate in this installation are much more rigorous than would be the case in a conventional boiler installation, and for this reason the tube cleaning operation is much more critical. Gases passing through these air heaters are laden with sodium carbonate and sodium sulfate particles which adhere to tube surfaces and would, if allowed to collect, prove disastrous to the operation. Many comparable kraft mills are forced to operate various steam and/or vibrating systems on a continuous basis.

For the Wisconsin Rapids installation, Diamond Power Specialty Co has designed and installed a shot-cleaning system that, to date, has operated satisfactorily on a 15-minute cycle. Between 800 and 1000 lb of steel shot are bounded vertically through the air heater tube passages, cleaning the surface as they fall. Shot are then collected in an accumulator at the bottom of the heater and blown to a storage tank above the heaters for the next operation. Compressed air at 100 psi is used to transport the shot from the bottom hopper to overhead storage tank. THE END

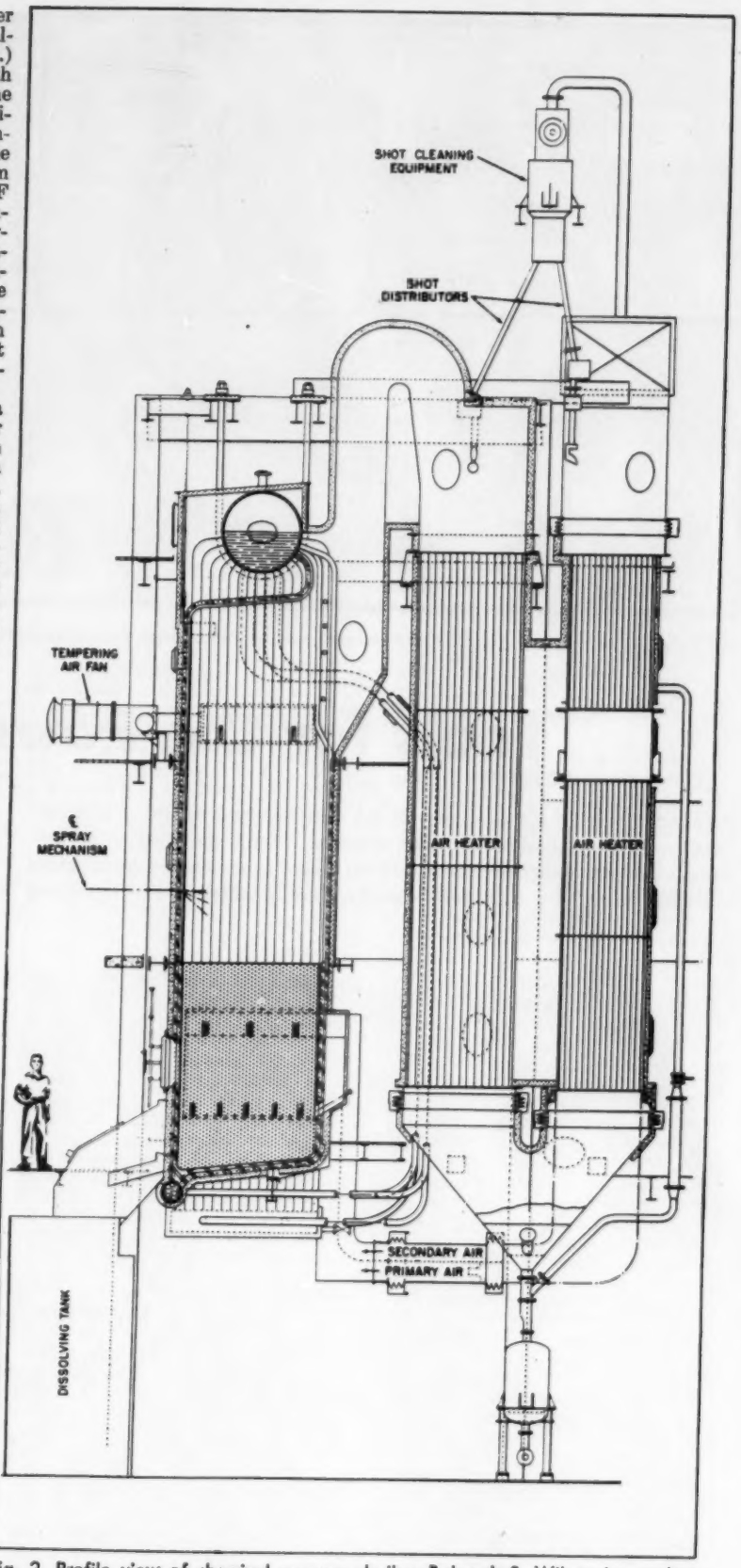


Fig. 2. Profile view of chemical recovery boiler. Babcock & Wilcox is supplier

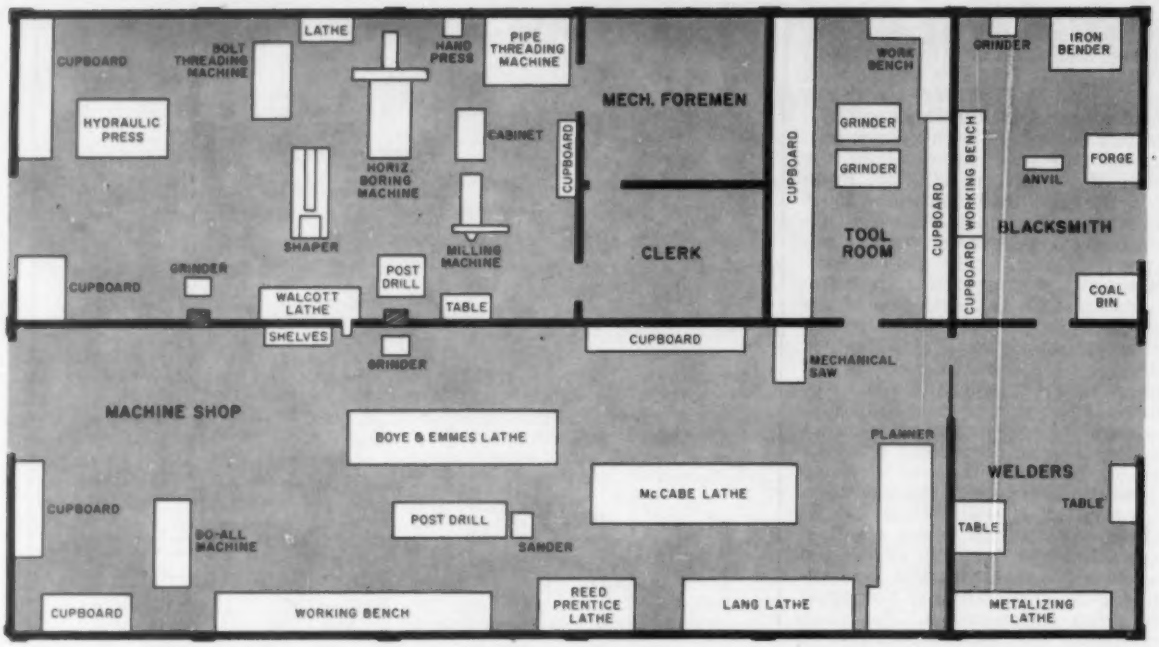


Fig. 1. Layout of the central facility and maintenance shop of a large Canadian utility. Shop is equipped to handle any job

Tools for the Power Engineer

Adequately manned and equipped maintenance shops are absolutely essential in electric utility systems. When the system is far-flung and made up of steam, diesel and hydroelectric generating stations, as is this Canadian utility, the problems are complex

By WILLIAM BUCKSHEE

THERE PROBABLY ISN'T a more exacting maintenance problem in the world than that associated with a large electric utility system made up primarily of hydroelectric generating systems. When some of these stations are widely scattered over a semi-wilderness area, as ours are, the job is even more demanding. Here, it is largely a do-it-yourself operation, for we don't have the outside service shops immediately at hand, as do so many of our more fortunate neighbors to the south.

Ours is a centralized maintenance shop and tool center serving one of the largest and oldest Canadian electric utility systems. From our centralized facilities, several generating plants are serviced. As in all electric utility maintenance operations, this is by and large a problem of having the right man or men, with the right tools and equipment, at the right place at the right time. Anything less can only result in undesirable outage, reduced system capacity, and an unhappy top management. Needless to say, such occurrences are extremely rare.

In providing necessary equipment and personnel, jobs that aren't too large for transporting are brought into the shop. When this isn't possible, the shop goes to them. Assume, for instance, that there is an overhaul job scheduled for one of our plants some 100 miles north of our central shop. Job is first analyzed in detail, after which all necessary arrangements are made to complete the work involved. We then ship them welding machines, impact wrenches, and the like. We, of course, have a crew of specialists who are sent along with the tools on major overhauls.

Shop Is Equipped For Any Job

Jobs range all the way from machining a new pump shaft, which we would do in the shop, to turning down a water wheel, or grinding smooth a weld repair to the inner surface of a badly cavitated throat ring of a hydraulic turbine weighing several tons, which would have to be done in the field. (*Editor's note:* See POWER ENGINEERING for May, 1959, for an account of this latter operation.)

Knowing that the responsibility for maintaining such a system in operation would be great and the job categories widely varied, we designed the central facilities, laid out the shop, specified and bought all needed tools and equipment with this in mind. Layout of our facilities is shown in Fig. 1.

Rather complete listing of principal shop equipment, as well as portable-power and hand tools is on page 85. Actually, it is not entirely complete due to the fact a complete listing down to the last crescent wrench and screw driver would consume several pages. All major tools are listed, however, and it is an extensive list.

Reason for this rather large stockpile of tools is that we, as a centralized shop, to a large extent look after tool requirements of other stations in the system as well. There are two reasons for this. First, we are in this manner assured of having the proper tool where we can lay hands on it in short order when needed. This, in itself, is sufficient reason, located as we are in an area where prompt replacement is not always assured. In addition, there is a substantial saving in that there is no large duplication of tools in other stations on the system.

Fig. 2. View of maintenance shop showing a wide variety of repair jobs in progress

LATHES

1 — Do-All contour machine, model V-36
1 — Boyce & Eames lathe, model C
1 — Reed Prentice geared lathe, 16" by 8'
1 — Walcott lathe
1 — Petrie engine lathe
1 — 16" Hang lathe
1 — Heavy lathe, 42" (S.H.)
1 — Small lathe
1 — Pipe lathe (S.H.)
1 — Metallizing lathe
1 — Endrite metal cutting lathe

OTHER PRINCIPAL EQUIPMENT

1 — Milling machine
1 — Shaper
1 — Large radial drill
1 — Small drill press
1 — Planer
1 — Emery wheel
2 — Hearths, work bench and tools
1 — Heaps threading machine
1 — Large pipe threading machine
1 — Pipe bender
2 — Welding machines
1 — Bench and grinder
1 — Special grinder
1 — Racine utility saw, model W3B
2 — Auto fluid drives
1 — Hack saw machine, 10"
1 — Hydraulic jack, 100 ton
1 — Boring machine

PORTABLE AND HAND TOOLS

2 — Thor electric drills
1 — Cleveland air-driven drill
1 — Black & Decker electric drill
1 — Atlas bench drill press
2 — B & X Shorty electric drills
1 — Mall electric drill
3 — Wiedeke tube expanders
1 — Ruemelin sand-blast generator
1 — Ingersoll air-driven grinder
1 — Dumore Metco electric grinder
1 — Hisey precision grinder
1 — Nu-matic air-driven grinder
1 — Baldor Carbide grinder
2 — Aro straight grinders
3 — Aro portable grinders
1 — Hisey precision lathe grinder
1 — Black & Decker electric grinder
3 — Metco metallizing guns
7 — Chain hoists
1 — Norton 25-ton jack
1 — Ruemelin sand-blast machine
1 — Belt-lacing machine
1 — Yale key-cutting machine
30 — Micrometers, assorted Browne & Sharpe, Goodhell-Pratt, and Starrett
5 — Crowfoot pullers
2 — Cleveland reamers
1 — Whitney punch, complete with dies
2 — Butterfield hand reamers
1 — Portable sander
2 — Do-All saws
1 — Black & Decker portable quick-saw
1 — Power King sander
1 — Black & Decker portable sander
16 — Wire rope slings
1 — Arc-Air torch, complete
1 — Metco compressed air drying unit
1 — Metco fuse-bond unit
1 — Metco gas-flow meter unit
1 — Metco air-blast unit
8 — Vises
1 — Oxweld acetylene set
1 — Blowpipe welding set
1 — SS welding and cutting set
2 — Ingersoll-Rand impact wrenches
11 — Socket wrench sets
1 — Platform truck
Assorted gages, drills, dial indicators, calipers, cutters, and various accessory tools for machine tool units

(Another article on "Tools for the Power Engineer" will appear in a subsequent issue.) THE END

WOULD YOU LIKE TEAR SHEETS?

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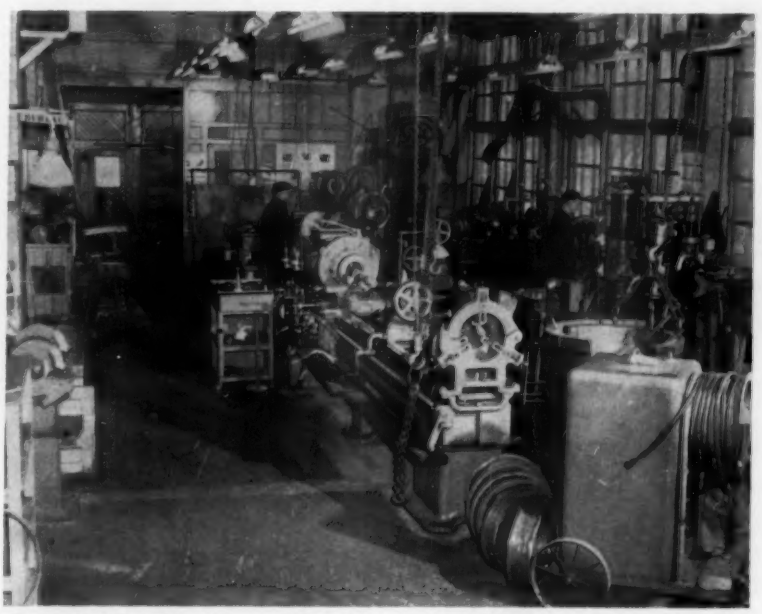
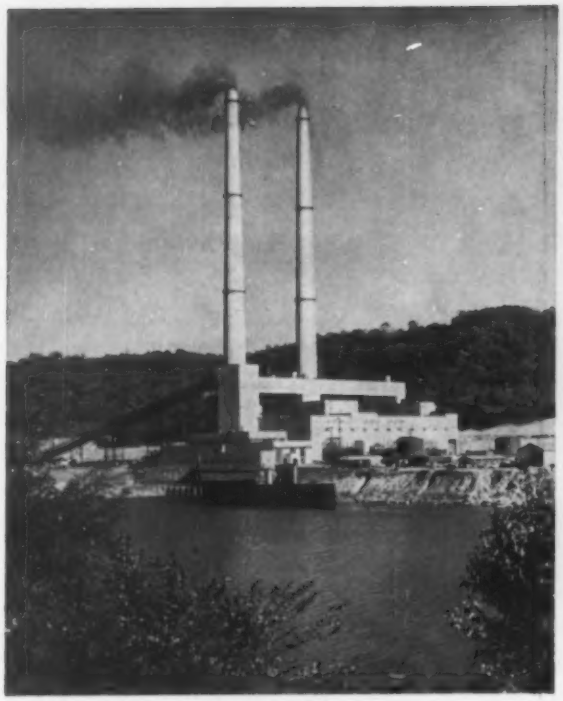
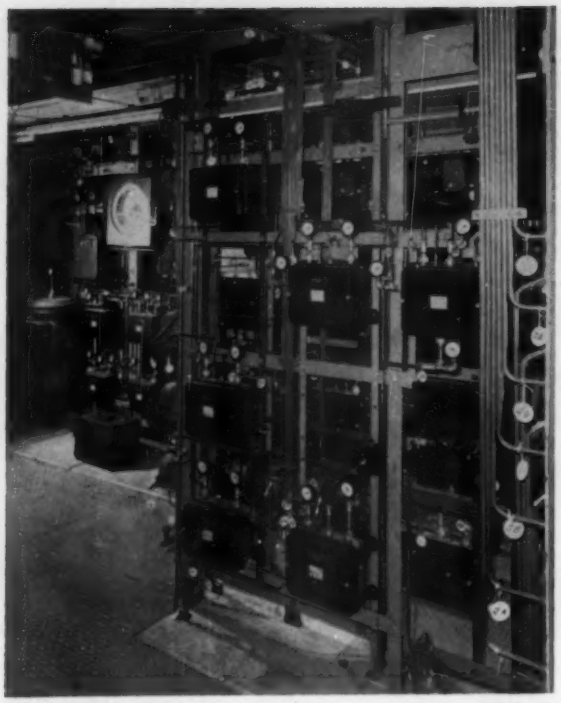


Fig. 3. Another view of same shop. Note compact arrangement of machine tools



A MODERN POWER STATION requires many sizes, kinds and types of pipe to make it complete.....



LIKE THIS small instrument tubing, used in thousands of feet, required for recording and control, and.....

It Takes a Lot of Pipe to Build A Large Power Plant

In modern electric generating plants today, piping is important. From the small instrument tubing, to the large condenser cooling lines, most every size and type of pipe is used. This story explains some of the complexities of a large steam plant piping installation

By DAVID D. VIGREN*

ON THE OHIO RIVER, near the village of Cresap's Grange, W. Va., and 19 miles from Wheeling, the giant Kammer power plant stands completed and is now in full operation.

This 675,000-kw station is a joint undertaking by the Ohio Power Co (operating subsidiary of American Electric Power Co), and the Ormet Generating Corp. It will furnish the all-important power required for the vast aluminum facilities of Olin Mathieson and Revere Metals, at Hannibal, Ohio.

A highly-varied power-piping project was carried out at Kammer, which incorporated the newest design features in this type of generating plant. Work included erection of piping (and system components) from 66-in. circulation water lines to an instrument control-air system of ¼-in. copper lines. Main steam piping is 12¾ inches o.d., with wall-thickness of 2¼ inches.

American Electric Power Service Corp engineers have used a tried-and-proven system of design to bring high efficiency to the Kammer plant. Specifications called for piping as required for three 225,000-kw, cross-compound turbine generators, operating at 2000 psi and 1050 degrees F, with one stage of reheat at 500 psi and 1050 degrees F.

Division of Work

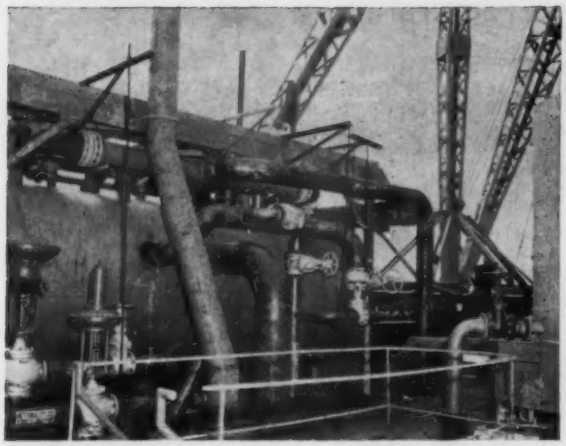
Each generating unit is fed from a single steam generator, producing 1,523,000 lb of steam per hour. A noteworthy design feature is that this is the first power plant in the world made to burn either coal or char. (Cyclone furnaces were designed by Babcock and Wilcox.)

Kammer represents the last word in refinement of AEP's 225,000-kw units. Five other generating units of this design are at work in the AEP System. These are at the Muskingum River, Glen Lyn and Clinch River plants—"kilowatt factories," as their engineers aptly call these modern power stations.

American Electric Power was the contractor, design-engineer of the project, and (as in most power plant jobs) furnished the equipment components, piping material and supplies. Pipe, of 6-in. size (and over) came prefabricated, while our company fabricated everything under 6-in. size in shops at the site. Engineer-detailing of 4-in. to 2½-in. work was also done on the job under our job engineer. Smaller lines were *field run*, and any changes were engineered as they developed.

Design required that all main steam, and reheat steam, piping be supported on constant-support springs, which would accommodate expansion with variations in operat-

*F. H. McGraw and Co



MEDIUM SIZE PIPE, as shown in this photo, which includes several pressures, for general piping facilities.....

PLUS HEAVY PIPING, used for the high-pressure steam lines, connecting boiler to turbine.....

ing temperatures. This was true of other hot systems, also. Periodic examination of these supports was stipulated, for an initial operating period, to assure that design movements were attained.

Twenty-one welded joints in the h.p. steam lines of each generating unit at Kammer were made with *consummable-insert rings* instead of the conventional split commercial backing-rings. The root pass, fusing the ring into the pipe, was made by the inert-arc method, with internal gas purging. Then followed careful examination by x-ray and with dye penetrant. The weld was then completed by using metallic-arc. All high-pressure steam piping contains 2¼ per cent chrome and 1 per cent molybdenum, and the insert-rings are made of the same material.

A single turbine-driven boiler-feed pump (5200-gpm, 6000-ft head per unit) has been employed at Kammer. Steam is taken from the exhaust of the main turbine and operates the feed-pump turbine at 5500 hp. Bleed steam is also taken from this turbine for feedwater heating. A low-pressure, motor-driven start-up pump is used to build up initial pressure in the boiler until the feed-pump turbine can be started from a connection to the main steam piping.

Generators are hydrogen-cooled, with four hydrogen-coolers in each generator housing. Hydrogen is supplied from a storage-bottle arrangement, tapped into a distribution system. The coolers are cooled, in turn, by condensate.

Three separate oil systems are used on each unit, serving the forced-draft fans, boiler-feed pump turbine, and the main turbine generators.

Another interesting feature at Kammer is a permanently installed chemical-cleaning distribution system. Nozzles on the main headers of the chemical-cleaning system are connected to nozzles on the feedwater system, and on the h-p heater drain piping, enabling the heater to be chemically cleaned when the unit is out of service. Supplementing this, the design also enables the shell side of the heaters to be cleaned during operation by isolation of a heater from the feedwater and extraction-steam systems.

Building heating was another part of the piping job. Being a semi-outdoor plant, much of it is exposed to the elements. Enclosed and heated, however, are the turbine rooms, parts of the heater bays where extraction feedwater heaters are located, and certain smaller areas, such as the boiler-drum enclosures, where important instruments are located.

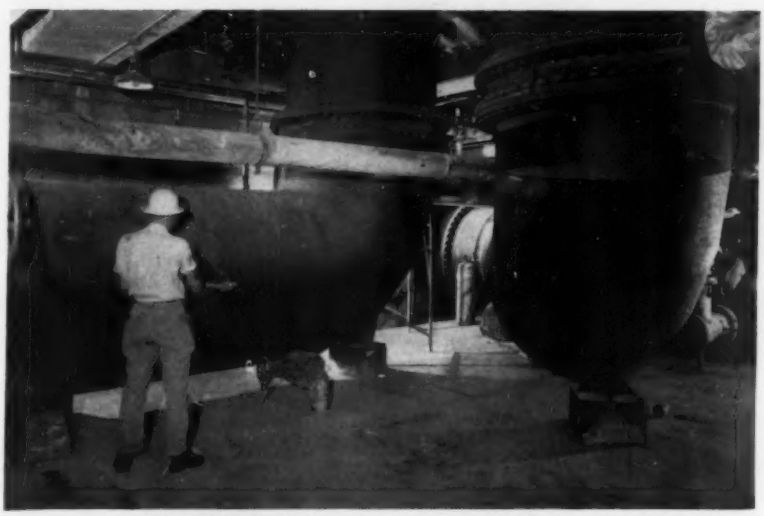
Control System Piping

In the boiler-drum enclosures, the water-level gage is continuously monitored by a television camera, which sends its picture to the main control panel where it can be compared with that sent in by two other level-recorders. The drum enclosure is normally warmed by radiation from the boiler, but freezing of water-filled parts must be prevented during shutdowns. Water lines in outdoor parts of the plant are kept warm by electric heating cables.

One man can control all functions of a generating unit from a large, modern control room. With a complete view (and throttle) of Kammer's works before him, he can elect automatic or manual control. Control rooms for units 1 and 2 are located back-to-back on the roof of the turbine room. Unit 3 control room is located in its unit area.

Through electric control cables and pneumatic air lines, impulses are carried from the machines to dials and relays here. These lines run via subpanels located adjacent to the vital equipment.

Noteworthy in the Kammer plant is the magnitude of the control sys-



.....**AND REALLY BIG** condenser-cooling pipe conduits as shown here

tem. Jointly, our company and AEP set up a small "factory" (in Wheeling) for assembling instruments in the control boards. First, the instruments were mounted on the panels; then, while the internal piping was being installed, electricians wired the instruments.

At the plant site, installation crews tied the control tubing, now assembled on the panels, into plant lines. The handling of the quarter-inch copper lines, as they run from end to end of the plant, and the precise angles of straight-line leads into fittings at the instruments, is tedious, painstaking work, to be done by experts.

Power from Kammer is delivered to the aluminum facilities (10 miles down river at Hannibal, Ohio) on two 132,000-v double-circuit transmission lines. The $91-million Kammer plant is an integral part of a major new industrial complex, which also includes the new Ireland Mine of the Consolidation Coal Co, the Ormet smelter, and the Olin Mathieson aluminum rolling mill.

Kammer is expected to consume 1,800,000 tons of coal each year, all of it from the Ireland Mine, located adjacent to the power plant. Coal is delivered from the mine's cleaning plant on a conveyer system one-third of a mile in length. Initially, the three boilers will burn only coal, with the use of char to follow after completion of a char-processing plant by Consolidation. (*Char* is a by-product from the low-temperature distillation of bituminous coal.) Boilers have been designed to burn either char or coal in any proportion.

Ownership of Kammer's generating units is divided, with two units the property of the Ormet Generating Corp and the third owned by Ohio Power. Since Kammer will be part of the American Electric Power System, the aluminum operations at Hannibal will be backed up by the power resources of the network; and, reciprocally, Kammer's surplus will go into the grid.

On April 6, the third and final 225,000-kw generating unit went into commercial service, and the plant is now in full-scale operation. With a peak force of 400 pipe-fitters, approximately 1600 tons of piping have been erected to complete this great plant — for its sizable contribution to industrial production in the Ohio valley.

Editor's note: All photos courtesy of F. H. McGraw and Co. THE END

Listening to the Sound Speeds Fault Detection

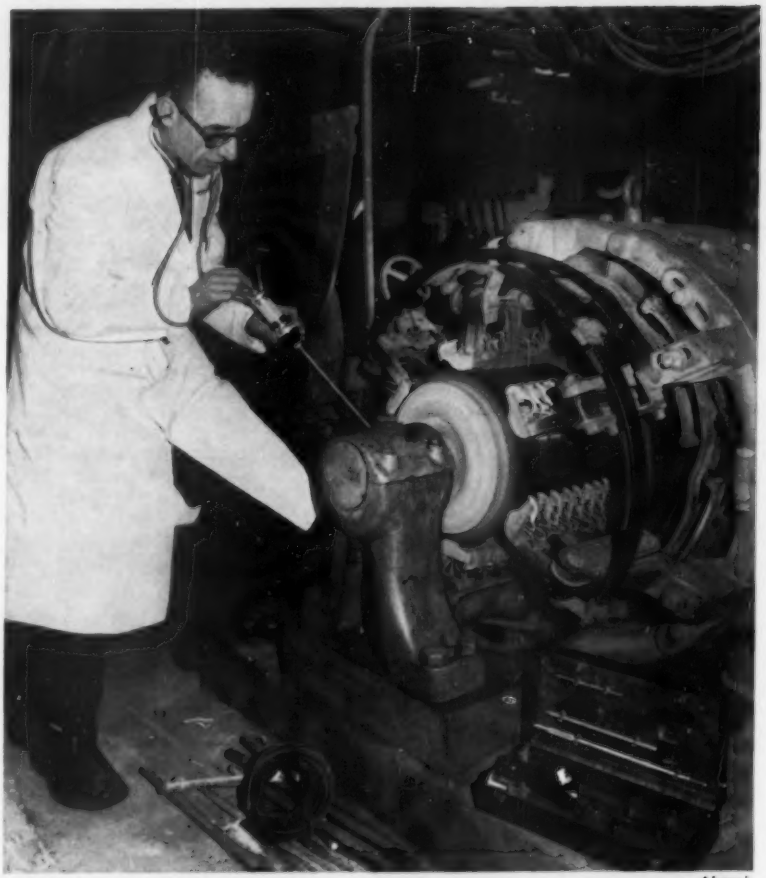
DIAGNOSING defects, misalignment, excessive wear and vibration, leaks, and non-uniformity in all kinds of mechanical equipment can be a laborious procedure, often accompanied by more dismantling and downtime than is strictly necessary. To simplify the job, experienced operators today are turning to the industrial stethoscope, of which several good examples are now on the market.

Such a device can be used on all kinds of pumps, generators, turbines, gasoline and diesel engines, compressors, condensers, electric motors, convertors, gages, recorders, boilers, and fuel lines — to mention only some of the applications. In the amplified sound that he hears, the operator can spot trouble sources quickly.

One such device consists of a metal probe which serves as a microphone, an electric amplifier and selector housed in a handy carrying case, and a set of ear phones. Adjusting knobs give volume control and sensitivity. When the probe is placed in contact with the suspected source of noise, the sound is amplified many hundreds of times, and the exact point of trouble can be spotted by moving the probe to different locations to determine where the sound is loudest. In this way, sounds normally heard only at high operating speeds can be detected at low speeds.

Another type of industrial stethoscope is non-electric, has a specially-designed sound chamber, isolates sound of the machine or part by special tuning device, weighs less than three pounds.

One of the oldest of these stethoscopic devices operates on the principle of the seismograph. When placed on the ground it detects vibrations from a distance through the rarification and compression of the air in the tightly sealed instrument. These vibrations are transformed into sound waves and carried to the ears of the operator through tubes and stethoscopic earpieces. This instrument has proved very effective for detecting water or steam leak locations.



Airsoni

Use of an industrial stethoscope simplifies the finding of defects in the performance of all kinds of power equipment. Tuning in on the sound leads to trouble sources

For names of manufacturers of industrial stethoscopes write The Editor, POWER ENGINEERING, or jot Industrial Stethoscopes on the return postcard enclosed in this issue.

Fig. 1. Cyclone-type twin-tower silencers limit noise of escaping steam to the roar of heavy surf when heard from a mile away

New Zealand Harnesses Subterranean Steam for 250,000 Electrical Kw

By STEVE LIBBY

WITH THE FIRST electricity from Number One high-pressure turbine at Wairakei geothermal power station now being fed into the system, New Zealand has harnessed for its homes and factories some of the vast store of energy so evident beneath the earth's surface.

Placing this turbine on commercial load culminated ten years of patient study and effort on a project for which the world has no precedent. Only one other nation uses steam from natural sources to provide electricity on such a scale: Italy's Larderello development. But a U.S. development is now being planned.

This is the first step in the government's $45,000,000 three-stage undertaking which will ultimately boast a capacity of more than 250,000 kw. It will take a year to complete Stage One, of 69,000 kw, for which two high-pressure, two intermediate-pressure and three low-pressure generating units are needed.

When Stage One is running at full capacity, the generating station will be using 956,000 lb per hr of dry steam to produce about 510,000,000 kwh of electricity a year — a result which would require 500,000 tons of coal a year in a conventional steam station.

From 8-in. bores averaging 2000 ft in depth, h-p steam is emitted at 392 F, at 210 to 220 psig after separation of the water, leaving a slight amount of superheat. I-p steam is at 75 to 85 psig. Turbine throttle pressures are 180, 50 and 0.5 psig.

Five 20-in. mains, totaling eight miles in length, carry the steam to the power plant, approximately 1½ miles from the field. Several miles of smaller piping collect steam from the individual well-heads. Bellows-type stainless-steel expansion compensators have been used.

All condensate collected, both at the well-head and throughout the system, will be flashed to steam to recover the maximum amount of heat. THE END

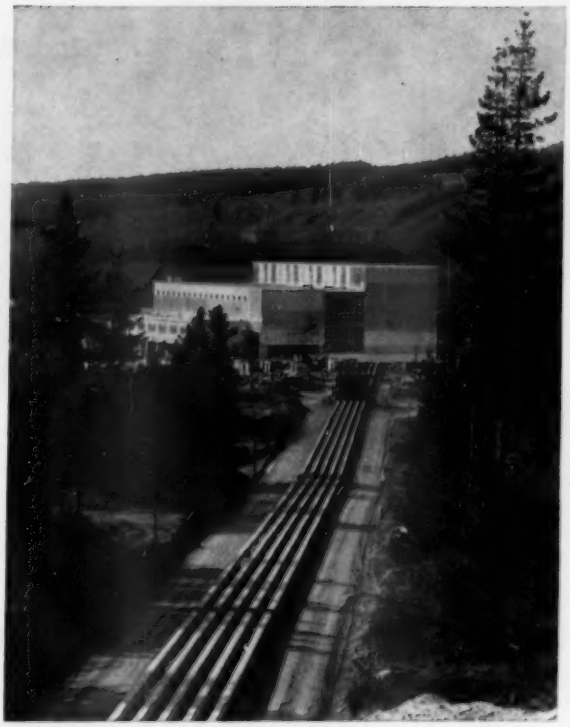
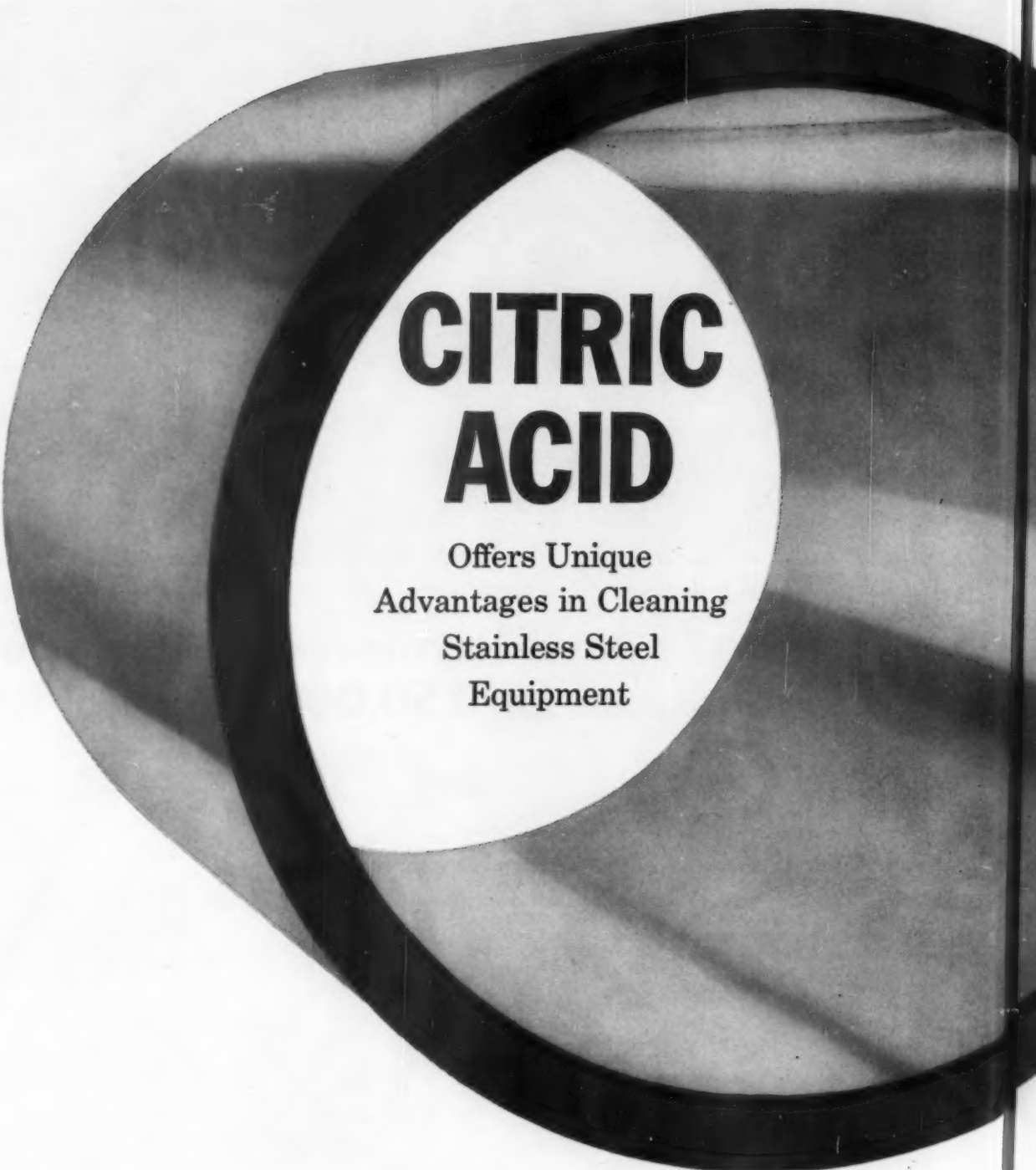


Fig. 2. Approach of steam to plant. Aluminum and glass have been used extensively with color. Note lack of smoke stacks



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3. Citric acid cleaning completely eliminates the possibility of chloride stress corrosion.
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Power Engineering handbook

How to Maintain Centrifugal Pumps

9 — Complete Pump Inspection

By J. A. CABLE * and O. M. KRISTY, Jr.*

IT IS DESIRABLE periodically to give the pump and drive a complete inspection of all components to keep the unit in good running order. How long to run between inspections can only be determined by the amount and type of service the pump performs. The greater the hours of operation and the more severe the service, the shorter the periods of operation between inspections.

Because operating conditions vary so greatly, it is recommended that a periodic record of the following data be kept as a guide:

A. Hours of operation.
B. Head and capacity (as related to rating for which pump was purchased — measure both suction and discharge head).
C. Horsepower required at above operating conditions.
D. Speed (this concerns data taken above and may indicate driver condition).
E. Bearing temperature and noise.
F. Packing adjustments.
G. Lubrication attention.
H. Alignment checks.

As an example of how these data will help determine when to "open" the pump and inspect it, let's say that the pump produces 2000 gpm, 100 ft head at 1750 rpm, and uses 58 bhp when it is new and clearances are at drawing dimension. As the pump parts wear, internal leakage will increase and efficiency will drop, causing an increase in horsepower required for equivalent head and capacity. As wear increases, the pump will eventually be unable to supply the demand. Therefore, repeated checks of horsepower used, measure of head and capacity compared to requirements when the pump was new, will provide a measure of wear and allow for inspection and replacement prior to complete failure.

Since "complete inspection" calls for opening the pump, as well as possibly dismantling the rotor, it is necessary to have a complete list of materials and clearances as well as certain spare parts on hand.

The various important components comprising a pump assembly, along with identity and rated conditions of pump and driver, are shown in the card reproduced here. Reverse side of this card provides space for a case history of inspection and repairs for this particular piece of equipment.

Complete inspection consists of opening the casing and removing the rotor. All machined casing bores must be cleaned down to bare metal. Make certain there are no nicks or burrs in any of the grooves holding tongue portions of stationary rotating element parts. On an average, the casing bore will be

*Application Engineer and Supervisory Engineer, respectively, Centrifugal Pump Dept, Allis-Chalmers Mfg Co

fold along this line—outside edges toward you

Serial No. ..... Size and type ..... Make .....
Date installed .....

PUMP RATING		STUFFING BOX		PUMP MATERIALS	PART NUMBER
Capacity	Gpm	Size: O.D.	I.D.	Casing	
Total head	Ft	Packing		Casing rings	
Suction (+ or −)	Ft	No. rings		Casing bushing	
Speed	Rpm	Packing mfgr.		Impeller	
Liquid		Packing No.		Impeller rings	
Temp.		BEARINGS		Shaft	
Spec. grav.		Coupling end		Shaft sleeves	
Viscosity		Type	Size	Seal cage	
Imp. diam.	In.	Outboard End		Gland	
		Type	Size	Shaft nut	
				Coupling	
				Casing gasket type	
				Thickness	In.
				Nominal wearing ring	
				Clearance	In.

Driver ..... Make ..... Serial No. ..... Type .....
Hp ..... Rpm ..... Frame ..... Ac or Dc .....
Volts ..... Phase ..... Cycles .....
Inlet steam, psig ..... Total temp F ..... Exhaust, psig .....
Control: Type ..... Make .....

Card like this, 10¾ in. by 8½ in., is invaluable as aid to complete inspection. Other side provides space for recording the case history of inspection and repairs for this particular equipment

0.003-in. to 0.005-in. larger on the diameter than the stationary rotating element parts, to prevent crushing of these pieces.

The casing main joint, which is usually gasketed, should be stoned to remove all rust, burrs or raised surfaces. It is also wise to stone the joint of bearing cap, bearing body, as well as the mating surfaces of bearing body and casing where the bearing body is bolted to the casing.

New Gaskets

New casing main joint gaskets should be cut to match exactly the contour of casing bores. This is best done by laying a solid sheet of gasket material over the joint of one half of the casing and lightly marking the cast and machined contour of the inner passages. The contour of the outside edge can be trimmed with a knife or cut by light hammer blows.

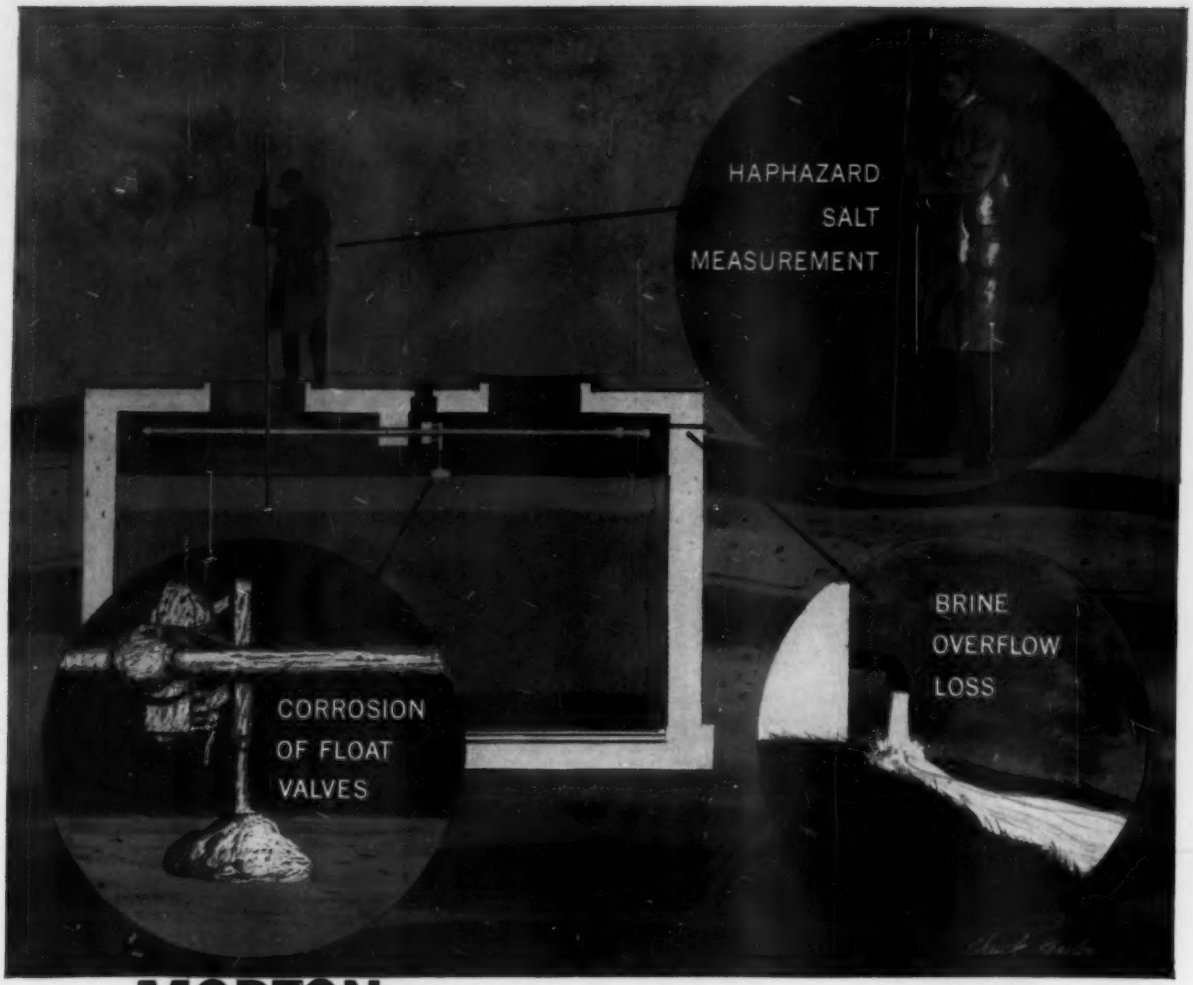
Remove the sheet of gasket material and cut with a scissors or knife about 1/16-in. inside the inner contour imprint, making a smaller incision in the gasket material than exists in the casing. Place the material back on the half casing, locate and hold with joint dowels, and clamp securely. With a fine, flat file trim the inside edge of the gasket material to exact casing contour. Be certain that the file strokes are vertical and that no actual filing of the casing edge is done. Don't ever cut the material on the inside edge with hammer blows.

Several types of gasket materials are available. However, a good all-around material for most any temperature or fluid is graphited asbestos service sheet.

On most all standard pumps a 0.015-in. or 1/64-in. thick gasket is used. This is also suitable (where required) for use between bearing bodies and caps. Do not use paper that is thicker than required for any horizontal split pumps. It is unnecessary to use any additional sealer or cement.

Worn Parts

The rotating element should be examined and all excessively worn parts replaced. Generally, rotating clearances are in the order of 0.010-in. to 0.014-in. on the diameter (based upon 0.0015-in. of clearance per inch of impeller wearing ring diameter). If the wearing ring is



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less than 6-in. diameter, this unit is increased, or if it is greater than 20-in. diameter, this will be decreased.

Generally, if the "close" running clearance exceeds two or three times the original clearances, the parts should be replaced.

Worn shaft sleeves and bearings should be replaced, as well as the rotating and stationary wearing rings, interstage bushings and casing bushings. If during dismantling the stuffing box packing is distorted or damaged, it should be replaced. These details were described in earlier chapters of this series of Handbook articles. (*Editor's note:* this series began in October, 1958 and has continued monthly, with the exception of December. Stuffing boxes with packing were discussed in October.)

Before and after assembly, the pump shaft should be checked in a lathe. Shaft and all rotating close clearance surfaces should be indicated and have no more than 0.003-in. run-out — total indicator reading.

The Rotor

Rotor should fit into the casing bores without pinching. After bolting the casing halves together, the rotor should be free to turn by hand. Unconfined by the thrust bearing, the rotor should have from 3/4-in. to 3/4-in. axial float. With the thrust bearing installed, the float should be virtually nothing with anti-friction bearings to 0.010-in. to 0.020-in. with a Kingsbury or sleeve and collar bearing.

The next — and last — article in this series will discuss in detail how to make the alignment of driver and pump.

Rotating element must be carefully centered in the pump stuffing box or boxes (within 0.002 to 0.004-in. of center) to allow for central positioning in the stationary close clearances. This can be done by moving the bolted-on bearing bracket (after which it is doweled in place), or by shimming of the bearing body or adapter. True line-boring of the casing fits and bearing bodies (if cast on the casing) will align the multitude of fits.

After the pump has been completely assembled, all vent, pressure relief and recirculation lines (if any) should be inspected and replaced, if necessary.

Suction and discharge piping should be disconnected, to make certain that no piping strain is being imposed on the pump casing. Casing strain will cause coupling misalignment, hot bearings, rubbing wearing rings and possible seizure of the rotor.

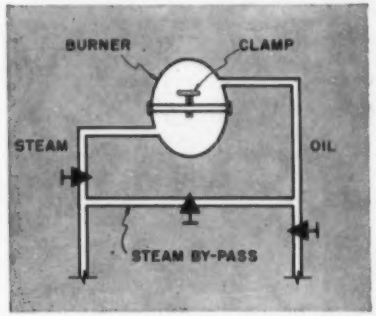
Driver and pump should be carefully realigned to prevent coupling wear, hot bearings and rotor rubs to driver and driven machine.

Here's a Way to Prevent That Oil Drip!

By JAMES M. CURRAN

WHEN BOILER PRESSURE in our plant (St. Raymond Paper in Desbiens, Quebec) begins to drop, we know that one of the burners is plugged at the tip. The burner is, of course, very hot, and when taking it off and replacing it with a clean one, oil drops onto the floor.

We solved this problem by installing a by-pass between the steam and oil lines. When it is necessary to renew a plugged burner, the oil line to the burner is flushed out with steam by opening the steam valve on the by-pass and closing the oil valve. This prevents oil dripping onto the floor, and only the burner tip has to be cleaned.



By-pass between steam and oil lines prevents oil dripping on floor when burner tip is off

fold along this line—outside edges toward you

Estimate Evaporation of Water from Open Tanks

By JOHN D. CONSTANCE, P.E.

WHERE STEAM or moisture is released to the working space from open tanks or similar vessels, with resultant high humidity conditions, the problem often is to estimate rate of evaporation and provide for a reduction in moisture content of the room air.

In the case of steam, this escape rate is not too difficult a problem, but for hot water there has not been too much information disclosed in the literature. High humidity affects worker comfort, and presents quite a condensation problem with dripping from walls and roofs.

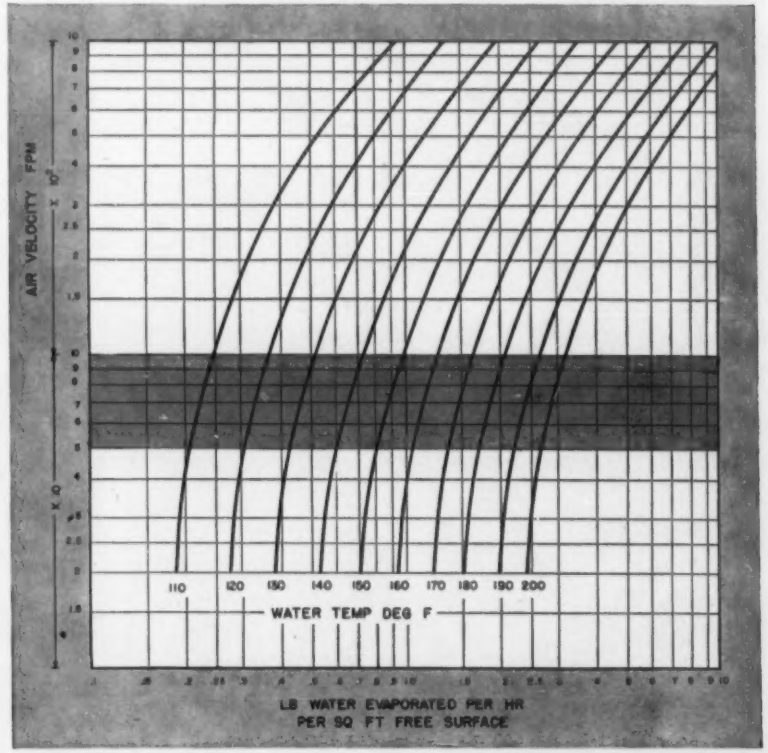
Typical industries in which this "wet heat" is found are:

Textile: elimination of fog and condensation in dye houses, bleacheries, and finishing departments.

Paper and pulp mills: elimination of high vapor in machine, beater, and grinder rooms.

Steel and metal goods: elimination of high vapor in pickling rooms.

Food industries: control of high vapor in kettle, canning, blanching, bottle



Graph gives quick results under normal operating and design conditions. Given air velocity and tank temperatures, rate of evaporation can be picked off graph. Dark band covers normal room conditions

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washing and filling areas.

Process industries: control of high vapor in electroplating, coating, and chemical processes.

Academically, the rate of evaporation from a free water surface is controlled by four important factors: 1. vapor pressure of the water at its temperature; 2. vapor pressure of the water in the surrounding air corresponding to its dewpoint temperature; 3. average effective velocity of the room air over the free water surface; 4. whether this air flows parallel or transversely to the exposed water surface.

The rate of evaporation with parallel flow is given by

$$W_p = \frac{95 + 0.425\,V}{r}(e_w - e_a)$$

With transverse flow

$$W_t = \frac{201 + 0.88\,V}{r}(e_w - e_a)$$

Where W = pounds of water evaporated per sq ft free surface per hr; V = velocity of air flow across surface in ft per min.; e_w = vapor pressure in inches of mercury at water temperature; e_a = vapor pressure of moisture in air above water surface; r = latent heat of evaporation at water temperature.

However, since time is of the essence and the plant engineer or designer would find it difficult and time consuming to evaluate all conditions, the graph shown on the preceding page gives quick results under normal operating and design conditions. Once knowing air velocity and tank temperature, the rate of evaporation can simply be picked off the graph.

Trouble in the Ice Plant . . . What Dunnit?

By C. T. BAKER*

ICE PLANT with 50 to 55 tons daily of ice-making capacity experienced trouble resulting from excessive condensing pressures. Capacity gradually fell off until the daily pull was down to 17 tons.

Investigation of the problem turned up some interesting facts.

First, for a year and a half the losses of ammonia, which were considerable due to leakage, had been made up with agricultural ammonia. Why? Agricultural ammonia could be secured for 7 cents per pound, as compared with 30 cents per pound for the straight anhydrous ammonia commonly used as a refrigerating medium. Agricultural ammonia does not possess the thermodynamic properties essential to a good refrigerant; and the producers of agricultural ammonia strongly advise against its use as a refrigerant. They stress the need for a commercially pure anhydrous product. Agricultural ammonia is produced for use as a soil builder. Its purpose is to build up certain soils that are deficient in nitrogen.

Second fact that emerged was that the mixture of the agricultural product and the lubricating oil carried over from the compressors had so completely insulated the coil surfaces from the surrounding brine that heat transfer between the two fluids was practically nil.

It required nearly two days of purging to free the coils of the accumulation of the oil and impurities deposited by the agricultural product.

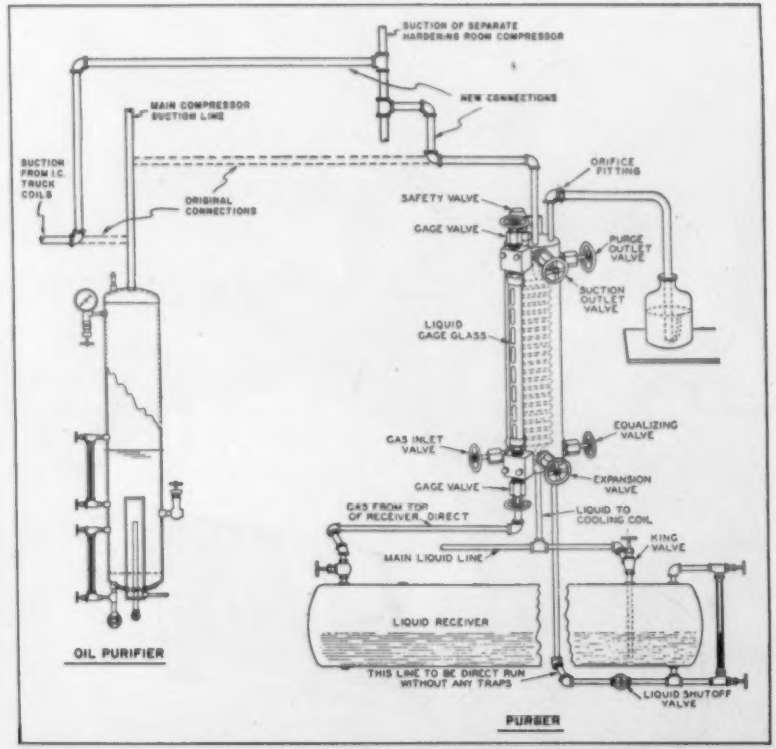
Fortunately, there was only a little liquid showing in the gage glass of the liquid receiver. This, along with the non-condensable gases in the piping system and condensers, was blown out and the system charged with the anhydrous product.

Thirdly, investigation showed that a good oil purifier had been installed some years earlier. It had proved entirely satisfactory as a device for collecting oil from the freezing tank coils, high pressure oil traps, and cooling coils in the ice storage room

During the time the plant was being cleared of the agricultural products, an examination was made to determine why this device was no longer used for the purpose intended. The plant operator said that it was not possible to withdraw oil accumulations on account of the presence of liquid ammonia. Checking further, it was found that the entrained liquid was carried into

* Consulting Engineer

fold along this line—outside edges toward you



A good oil purifier had been installed and had proved entirely satisfactory. But the liquid slop-over from the ice cream truck cooling coils was so excessive that the purifier was kept flooded with liquid ammonia. This was remedied by changing suction lines. Suction lines from purifier and purger were connected to main suction line. So was suction from the truck coils. Separate suction was provided from each

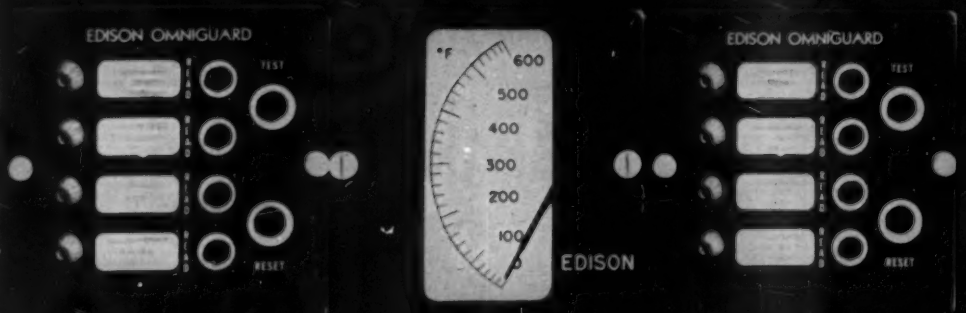
the oil purifier by the suction lines from six ice cream trucks that were refrigerated at night so as to be able to take out a load of cream the following morning.

Of course, it was never intended that the purifier be used as an interceptor of liquid ammonia from any source. Flow of refrigerant to the truck evaporators was supposed to be controlled by thermal expansion valves. It developed that these valves were entirely too large for the tonnage they were supposed to handle. They had been purchased second hand and since they did not fit the requirements, the control of liquid flow to the cooling coils was beyond the capacity of the coils to evaporate. Accordingly, much of the liquid passing through the truck coils was dumped into the oil purifier.

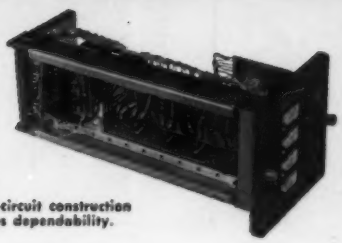
In addition to this hook-up, the suction line from a gas purging unit was also connected to the oil purifier.

This situation was changed and the suction from both the several trucks and from the gas purger was connected to the main suction line of a compressor used for refrigerating the ice cream department hardening room.

After things were put in proper shape, the ice output was increased from 17 tons to 51 tons per day.



Model 310 Edison Omniguard with Model 311 Indicator — a single indicator can read any number of temperature points.



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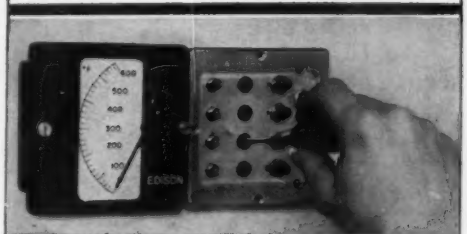

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4. SIMPLE: Single indicator reads any number of temperatures, needs no periodic adjustment. With a minute's briefing, *anyone* can operate the simple Omniguard monitoring system.

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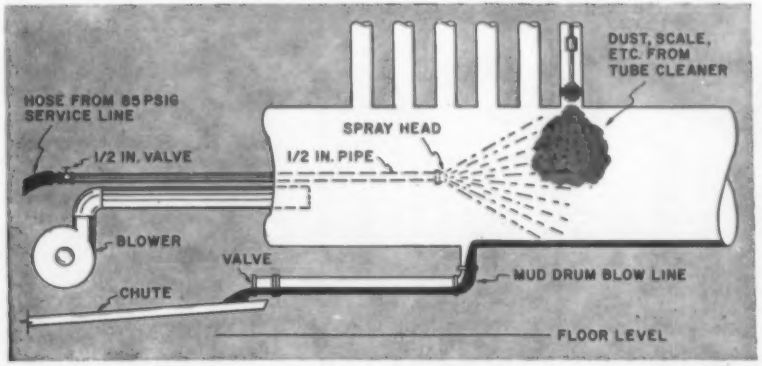


Scale and dust is settled by spray and washed out through mud drum blow line by water from this line. Blower is for cooling and ventilating. Large valve is Yarway seatless blowdown valve, plunger remove

Settle Dust in Mud Drum While Cleaning Tubes

By O'NIEL HOLMES

SKETCH SHOWS the system we set up to cool the working area and to supply adequate fresh air for the operator of the tube cleaner, while cleaning boiler tubes. This has worked very well for us at Armstrong Cork's plant in Millville, N. J.

Dust from the air-driven tube cleaner settled to the bottom of the mud drum by the spray of water, where it is flushed out the mud drum blow line. The air from the centrifugal blower is cooled by the water, also.

Before using this system, it was necessary to wear dust respirators. Now the men can work inside the steam drum without a respirator and much more comfortably for a much longer period of time.

Need to Bevel Those Carbon Brushes?

By VERNON E. GARDNER

MAINTENANCE men may have found themselves faced with the assignment of replacing a set of carbon brushes in which an appreciable amount of carbon must be removed before the brushes will fit properly. Sometimes a new brand of "sandpaper" will provide the answer.

This sandpaper, which is actually perforated thin sheet steel, is available at practically any good hardware store. It may be purchased in pieces approximately 4 by 5 in. in size, which can be mounted in the same metal hand-type holders used for conventional sandpaper.

A brush in need of beveling or trimming may be supported by hand on the edge of a bench, box, block, or any solid structure. Then, by taking the holder in the other hand and using a steady stroke from the elbow, the desired bevel can be approximated.

For greater accuracy, the brush may be held in a small vise, although in this case great care must be taken to avoid breaking the brush.

From experience it has been found that the bottom bevel of a brush 2 in. long, 1½ in. wide, and 1 in. thick can be changed as much as 30 degrees with fair accuracy in less than a minute.

fold along this line—outside edges toward you

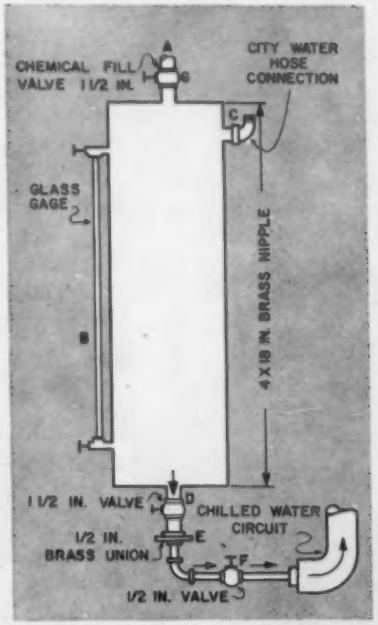
Inexpensive Way to Put Water Treatment Into Chilled Water Circuit

By JOHN KALMAN

RECENTLY at Passaic General Hospital, Clifton, N. J., we installed two large air conditioning systems in our surgical wing. The units are working very well, after minor difficulties were solved. One trouble involved putting the water treatment into the chilled water circuit. We were not able to find anyone who could supply a simple system. So, after much thought, we arrived at our own solution, as shown in the diagram, as follows:

1. Make sure that valve F is turned off.
2. Open valve G.
3. Pour the needed amount of chemical treatment into pipe A.
4. Close valve G.
5. Attach city water hose to connection C.
6. Open valves D and F.
7. Make sure expansion tank on cooling system is half empty.
8. Turn on city water and leave running until water in glass gage B is clear. City water forces additional water and chemical treatment into the chilled water circuit.
9. Turn off city water.
10. Turn off valves D and F.
11. Unit may be disconnected at E and used for other systems.
12. After unit is taken off at connection E, valve D may be opened to drain unit.
13. This injector may be used at any time. It does not matter if unit (cooling system) is running or not.

(*Editor's note:* Many people would have used a chemical proportioning pump to inject this water treatment material. But this would have involved an expenditure which Mr. Kalman doubtless did not want to make. His solution to the problem is ingenious.)



Treatment injector for air conditioning unit chilled water circuit. May be used at any time

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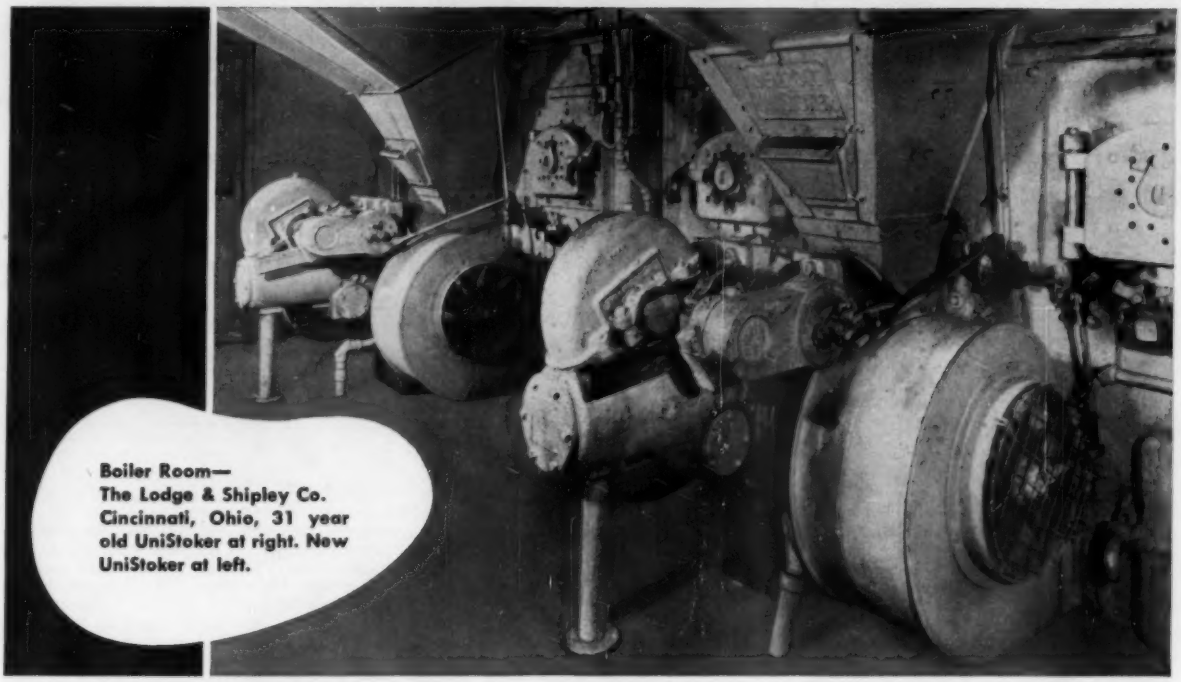
THEY JUST GO ON... AND ON*

31 Year old Detroit UniStoker is still serving and saving



Boiler Room—
The Lodge & Shipley Co.
Cincinnati, Ohio, 31 year old UniStoker at right. New UniStoker at left.

● A Detroit UniStoker installed at The Lodge & Shipley Co., Cincinnati in 1927 performed so well and proved the economy of UniStoker firing so conclusively that another UniStoker was purchased in 1958 when added steam capacity was needed to serve plant expansion.

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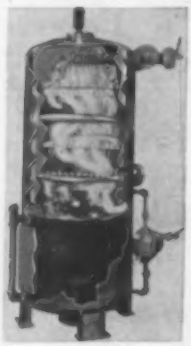
EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 113–114 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—FEEDWATER HEATER has improved vent condenser

This deaerating feedwater heater has an internal vent condenser in the form of a double-walled hood at the top of the heater. A series of opposing fins on the inside walls slows and condenses the rising steam. Air and non-condensable gases escape through the air vent valve to atmosphere. In operation, entering feedwater sprays against the underside of the hood, deflecting down in a fine mist, which falls onto the top baffle plate, runs down the slope and over a serrated edge onto the next baffle below. As water cascades down, steam flows up, scrubbing the water and sweeping air and non-condensable gases up through the vent condenser and out through the air vent. Only enough steam escapes to assure removal of the air, it is pointed out. Flow of steam and water in opposite directions provides maximum feedwater temperature with minimum steam consumption. Heaters are available with vertical or horizontal storage section, in capacities ranging from 3000 up to 300,000 lb per hour. Stickle Steam Specialties Co.



2—FLEXIBLE TUBING for pneumatic and hydraulic use

Synflex-N3 is announced as a flexible, lightweight pneumatic and hydraulic tubing for maintenance-replacement of conventional tubing and rubber hose and other applications. It is a natural color polyamide formulation for permanent use in lubrication systems, instrumentation, vacuum, chemical and effluent lines, and air lines to equipment and tools. Two basic types are offered: Group I low-pressure tubing for applications to 1500 psi, and Group II for medium pressure service to 2500 psi. Both types are available with outer diameters from ⅛ to ⅜ in. According to company, this tubing possesses lower notch sensitivity, greater flexibility, and resistance to internal or external abrasion. Synflex Products Div., Samuel Moore & Co.

3—PUMP-MOTOR UNIT is close coupled and compact

Series 42, a pump and motor combination, is offered for applications where space and weight are at a premium. Measuring only 9⅛ in. by 5 in., the unit incorporates a totally enclosed electric motor, rated for 1/12 to 1/6 hp, and an internal gear pump with a capacity of 1/3 to 3 gpm. There are 24 models in the series, all available with or without a relief valve. The Tuthill Pump Co.

4—LIQUID LEVEL CONTROL for wet salt storage

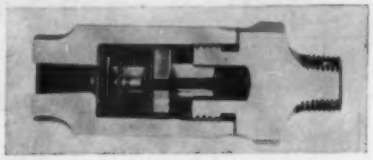
The Levetrol Brine System is a method of liquid level control in a wet salt storage system where water level automatically is proportioned to brine withdrawn. Adaptable to any wet salt storage system, it protects against salt loss due to brine overflow by balancing water level with salt level. According to company, Levetrol solves the problem of salt and water inventory and permits complete automation of water treatment system. Controls are located away from brine storage supply to avoid corrosion. Morton Salt Co.

5—PORTABLE TENSIONER features lightweight design

Catalog No. 4000 PM Tensioner is a portable weighing only 165 lb. Company says that it can be hauled on any truck to the job site, lifted by two men and quickly attached to a pole and the stringing operation started with any size conductor to a little larger than 4/0. In order to minimize weight, the gears from the bullwheels to the disc brake are housed in a magnesium casing. Hollow spindles are also incorporated. With a rating of any tension to 800 lb line pull, this tensioner is so designed that input fair-lead swings to either side, so that stringing operations can take place in either direction, even though pole may be immediately next to a fence or building. Petersen Engineering Co., Inc.

6—CHECK VALVE stops flow only when pressure is changed

For use at various ranges over high and low pressures, this spring-loaded check valve is designed to withstand up to 2000 psi hydrostatic. Because of noncorrosive features, it is suggested for use



on air, water, steam, gas or oil flow, or where corrosive liquids are encountered, at high or low temperatures. Of simple design, this valve is only 3½ in. long, 1¼ in. diam, and contains only four pieces — an R Monel body and cover enclosing Monel valve stem and Inconel spring. It installs in vertical or horizontal position, has ⅜-in. IPS threads at both ends. R. H. Wager Co.

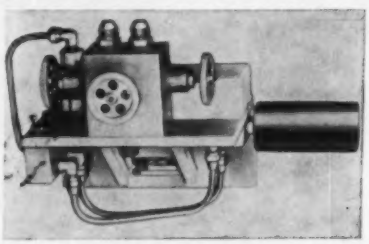
7—OFFSET HEX WRENCH works in close quarters

The No. F-110 Offset Hex Wrench is especially designed for use on hard-to-get-at sink and tub drain nuts and other nuts and fittings in tight quarters. Its

easy-on, non-slip, multi-sided grip gives extra leverage on all hex nuts, square nuts, valve packing nuts, unions and gas cocks. Thin jaws of wrench are designed to fit narrow nuts and slip into tight places. Maximum opening across flats is 2¼ in., and jaws are designed to handle up through 1½ in. drain nuts. The Ridge Tool Co.

8—PNEUMATIC TRANSMITTER for pressure measurement use

The Delta P Transmitter is a linear, force-balance instrument for pneumatically transmitting measurements of large differential pressures at high statics. Claimed capable of measuring full scale pressure differences up to 300 psi, this



instrument fills the measuring gap existing when pressure differences exceed capacity of standard instruments. Manufacturer recommends the Delta P for measuring pressure difference between steam header and boiler feedwater, and pressure drop across the superheater, between steam header and turbine throttle, or across high pressure

No. 1 choice for power stations... Crane Pressure-Seal bonnet gate valves

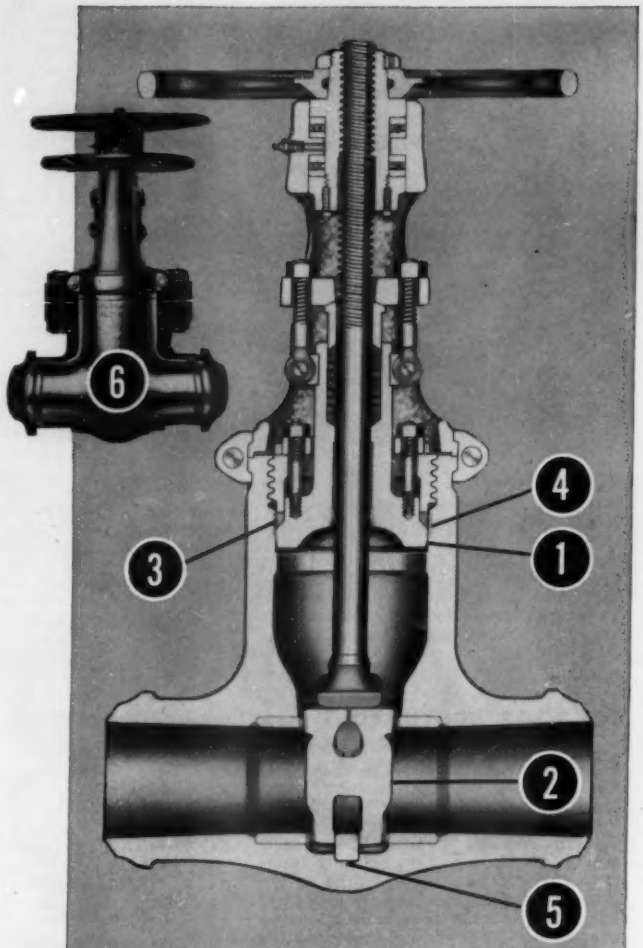
What makes a high-pressure/temperature valve long-lived, safe, dependable and economical to install and maintain?

In Crane Pressure-Seal bonnet gate valves it is:

1. **using internal pressure to seal the bonnet joint —the higher the pressure, the tighter the seal —eliminates bonnet-joint maintenance**
2. **a flexible wedge disc that prevents sticking when valve is closed hot and opened cold . . . doesn't jam even when seated with excessive torque**
3. **a one-piece, silver-plated seal ring held snugly in place by a chrome-plated retaining ring which is screwed into the body; ring remains freeze-free for easy dismantling**
4. **a wear-resisting stainless steel inlay in the body adjacent to the seal ring that insures tight sealing and maximum protection against corrosion at this important point**
5. **full-travel disc guiding—even at critical point of final closure; prevents wear and drag on seating surface**
6. **streamlined, weight-saving design—saves up to 60% of weight of conventional bolted bonnet valves . . . reduces suspension cost . . . simplifies insulating**

Crane 1500-pound Pressure-Seal bonnet globe and angle valves: 1" to 16"; socket- and butt-welding ends.

Crane's complete, expanded line of Pressure-Seal bonnet valves includes gates, globes, angles, globe lift-checks and stop-checks—in all standard sizes, ends and pressure classes. For complete information, see your Crane Representative.



Sizes 1" to 24"; 600-, 900-, 1500- and 2500-pound classes; flanged, socket- and butt-welding ends.

ALL CRANE PRESSURE-SEAL BONNET VALVES ARE ASA RATED

Minimum metal thicknesses comply fully with the requirements of ASA B16.5-1957, as well as ASA Code for Pressure Piping and ASME Boiler and Pressure Vessel Code.

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

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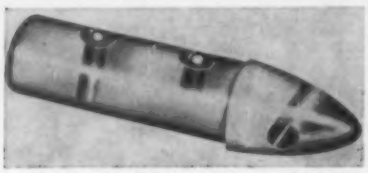
heat exchangers. Other uses include measuring pressure differences between stages of high pressure multi-stage hydraulic pumps or as a "square root" flow meter when pressure difference is extremely high. It is claimed useable at static pressures up to 3000 psi.

The high pressure transmitter receives two input pressures and converts the difference to a single output pressure directly proportional to the difference. There are no stuffing boxes or torque tubes, and shutoff and bypass valves are built in. Controls Div., Hagan Chemicals & Controls, Inc.

9—PLASTIC TUBE PILOTS speed equipment assembly

Light, easy-to-handle Guide-Rite Tube Pilots are designed for use with heat exchanger and boiler tubes ranging from $\frac{3}{8}$ to 1 in. O.D. According to manufacturer, these plastic pilots do the work of



heavier models at about a tenth of the cost. They are used to speed assembly of tubular equipment by piloting tubes through tube sheets, baffles, and support plates. Piloting serves to prevent damage to tube ends and eliminate need to fish tubes through holes. Pilots have a spring pressure feature to hold them in place, yet make removal easy. Thomas C. Wilson, Inc.

10—ROOF VENTILATORS are belt drive, Fiberglas units

Fiber-Aire Ventilators are so silent you can't believe they're running, says manufacturer. Instead of acting as a sound chamber, the Fiberglas housing absorbs noise and vibration, it is pointed out. It is also claimed virtually indestructible and able to withstand severe impact, weather, temperature and most chemicals. It is sky blue in color, low in contour. Forty-four belt-drive models in the Fiber-Aire line offer capacities from 180 to 13,500 cfm. They incorporate stainless steel air flow guides to prevent internal air shocks and add to operating efficiency. The Swartwout Co.

11—SPEED REDUCERS offer five basic improvements

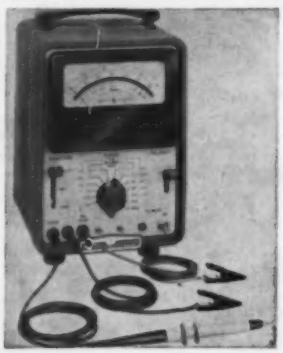
Unusual flexibility in mounting and drive arrangements are announced for this manufacturer's new line of heavy duty, worm gear speed reducers. Other improvements over previous standard designs are said to include higher efficiency; higher capacity; availability from stock of all ratios from $5\frac{1}{6}$ to 1 to 1212 to 1 with center distances from 3 to 21 in. and any horizontal or vertical drive arrangement; and torque control. Mounting and drive arrangements are more flexible because the line features one basic housing design for each size. Standardized mounting bases, worm gearing, single and double helical attachments, fans and torque control attachments permit top, bottom or side mounting with or without mounting base. All units can be supplied with a torque control attachment to protect driving and driven equipment from overloads. Philadelphia Gear Corp.

12—LINEMAN'S GLOVE has "built-in" warning signal

For those who work with high voltage, the Hi-Visibility Red 'N Black Glove offers an extra measure of safety. It is made of natural rubber by the standard multiple dip cement process, but instead of a constant series of dips in black rubber solution, the first series is in red rubber solution. If any significant damage to the glove has resulted from snagging or cutting, the black exterior is penetrated, and the red interior flashes its warning that the damage is substantial in depth. The red interior also helps prevent potentially harmful reversal of gloves, promotes cleanliness, because the red makes it easier to notice and wash off accumulated soil. Also, the red roll at the cuff signals at a distance that glove is in use. Charleston Rubber Co.

13—VOLTMETER also serves as ohmmeter, ammeter, amplifier

Model 412A, a compact, multipurpose voltmeter, is designed to measure d-c voltage, current and resistance — all over a wide range. Manufacturer annouces that it measures voltage between 100 microvolts and 1000 v (maximum full scale sensitivity 1 millivolt) with accuracy 1 per cent of full scale; current from 0.1 microampere to 1 amp (maxi-



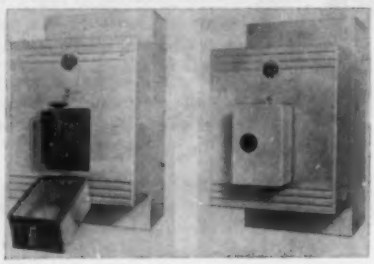
mum sensitivity 1 microampere), accuracy 2 per cent; resistance from 0.02 ohms to 5000 megohms. High stability and low drift are said to make this unit suitable for high gain d-c amplification. A maximum voltage gain of 1000 is provided. Amplifier output is proportional to meter reading and may be used to operate potentiometer or galvanometer recorders. Extreme stability of Model 412A eliminates need for a zero adjustment, it is noted. There are only three controls: function selector, 13-position range switch and lever-type polarity switch. Model 412A costs around $350.00. Hewlett-Packard Co.

14—VALVES, FITTINGS offer corrosion resistance, economy

Chief feature of valves and diaphragm protectors in the Chem-Line series is use of polyvinyl chloride for all normally wetted parts. PVC is so utilized because of its corrosion-resistant properties and lower initial and maintenance costs, company points out. In this line, parts not normally wetted by the contained fluid are of conventional materials. In the case of valves, the guide and disc holder and, in some cases, the housing are made of PVC. In the case of protectors, the diaphragm retaining ring and bottom bowl are supplied in PVC. J. E. Lonergan Co.

15—LOW VOLTAGE BREAKER individual enclosed, dustproof

For NEMA 1A applications, this is a dustproof model of the U-Re-Lite, individually enclosed low-voltage power circuit breaker designed to offer a "visible break" to provide a check on whether a



breaker is connected or disconnected. The new model is similar to the general purpose U-Re-Lite, but has a gasketed air-tight front cover. The front cover opening permits check of breaker position indicator, while side opening allows check of breaker contact position. Both openings have transparent covers. I-T-E Circuit Breaker Co.

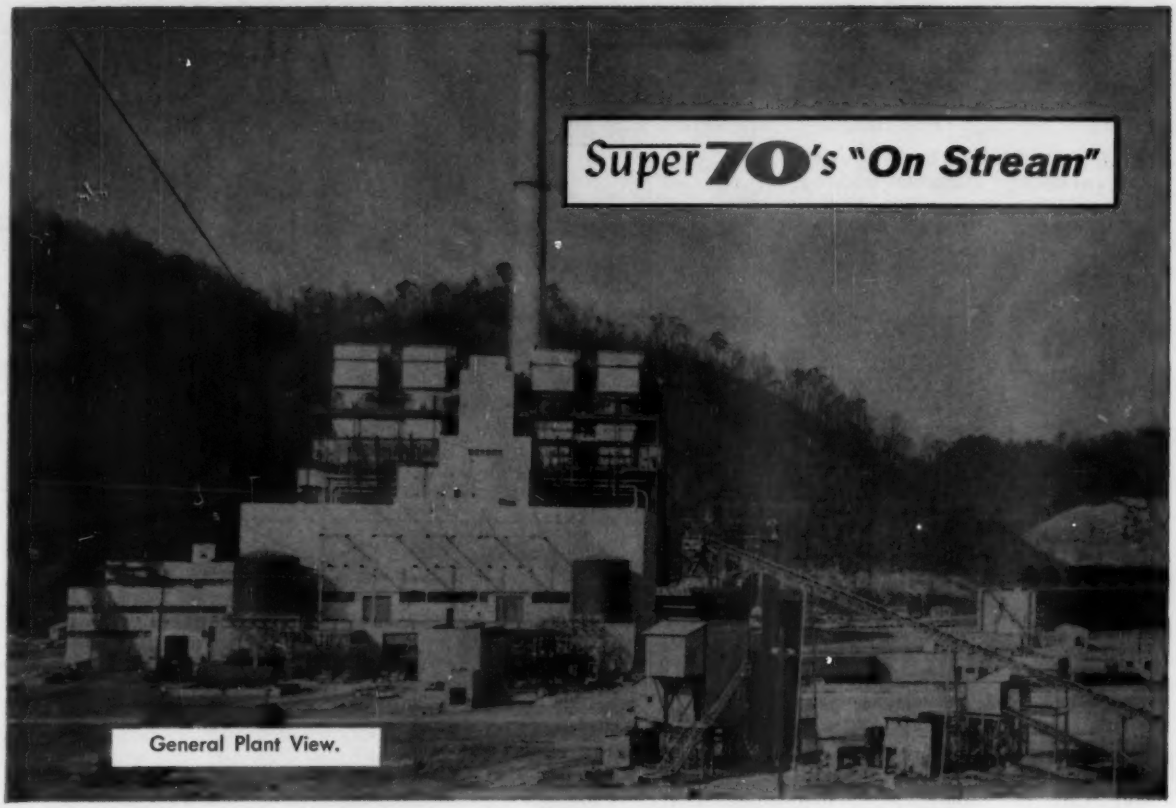
16—TRANSISTORIZED LOCATOR finds pipe, valves, cable

This transistorized pipe, valve and cable locator features single turn transmitting and receiving coil cast right into the fiber glass case. Transmitter and receiver are each powered by four flashlight batteries and have a built-in battery tester. The locator uses a total of 10 transistors, three in the transmitter and seven in the receiver. The transmitter has a switch to allow for good and poor conductive ground and the receiver has a three-position sensitivity switch plus a variable gain control. Gardiner Electronics Co.

17—COMPACT VALVE for use in hazardous services

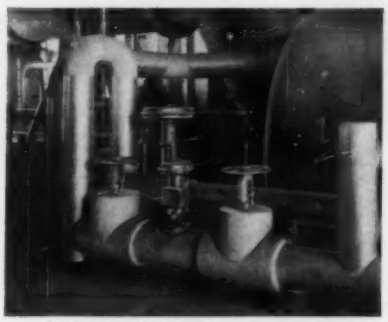
This is announced as a compact, leakproof valve with no moving parts between fluid chamber and atmosphere, and safe for handling radioactive and toxic fluids. For tight shut-off or automatic throttling of gases and liquids, the valve has negligible pressure drop across the closure disc. Internals can be made of any weldable corrosion resistant material, while externals may be brass or steel. Limits of design working temperatures are −20 to 1500 F; design working pressures range from 0.005 microns vacuum to 150 psig in smaller sizes; and to 30 psig, sizes to 72 in. diam.

Heart of the valve is a standard commercial bellows which forms the fluid chamber. The chamber contains only a seat and disc. There is no opening to atmosphere, no stuffing box or valve stem. The disc is opened and closed by

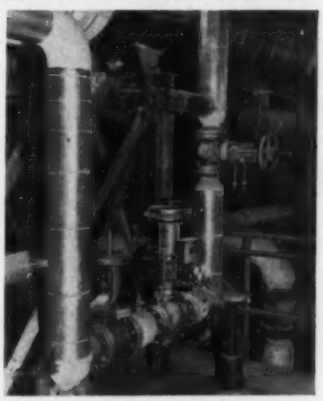


General Plant View.

Clinch River Plant, Units 1 & 2



High Pressure Heater Drain To Deaerator.



Number 4 Heater Level Control Valve.

Highlighting the vast power expansion program of the American Electric Power System, two additional 225,000 KW steam-electric generating stations were recently put on the line by the Appalachian Power Company.

In these fully automatic reheat stations, BS&B Super 70 Control Valves, together with BS&B Liquid Level, Pressure and Temperature Controllers, are employed in heater drain and other auxiliary control systems.

Engineering service, including preliminary engineering studies, multi-load analysis and start-up assistance were provided with BS&B Controls in the Clinch River Plant to assure unit responsibility as well as efficient and dependable system performance.

In the two world's-largest forthcoming 450,000 KW super-critical once-through stations, BS&B Controls will again render proud service to the Power Industry through the American Electric Power System.

BLACK, SIVALLS & BRYSON, INC.
Controls Division, Dept. 4-R7
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SUPER BS&B 70

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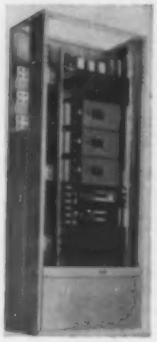
pneumatic or mechanical gear drive in 2- to 6-in. sizes, by mechanical gear drive in 6- to 12-in. sizes. Larger valves require hydraulic drive or synchronized motor. Singmaster & Breyer.

18—SWITCHBOARD features vertically stacked bussing

In this design, bussing is stacked vertically, rather than cross-bussed, and moved back out of the wiring area. It affords unobstructed working space and requires less wiring time. Installations are simplified in other ways, it is pointed out. An optional location of the cross-bar is possible and the need for bussed riser sections to transfer cross-bussing to a top or bottom location is, in many cases, eliminated. Also, the increased depth of 20 in. front-to-back, assures greater air circulation, while the 66-in. panel area provides maximum usable space. No need to weave cables between bars. Square D Co.



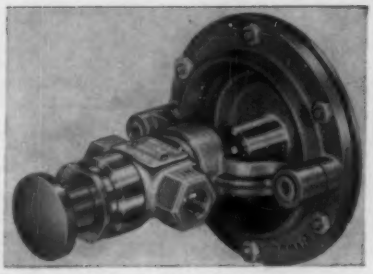
19—DUST SAMPLER is self contained, portable unit

Developed primarily to measure dust or fly ash loading of boiler flue gas, Unit TE-102 can be used to determine solids content of any gas stream even at high temperature or in corrosive gases, it is announced. It is a self-contained unit with filtering section attached to sampling tube and a separate blower. This keeps the size and weight of each low enough to be carried with one hand. Sampling nozzles and extension tubes are made with quick locking connections. The unit is made of stainless steel to withstand high temperatures or corrosive gases. Breslove Separator Co.

20—PACKAGED PUMP comes complete with controls

Type IND is specifically designed for general industrial boiler feed or other pumping service where medium volume

and high pressure are required. The compact unit is complete with controls for constant or differential pressure regulation. It is of simple, single stage design with turbine, pump and control in one integral matched unit. Capacities range to 180 gpm, discharge pressures to 350 psig. Coffin Turbo Pump Co.



21—AUTO-MANUAL VALVES for use in interlocked circuits

These auto-manual control valves are designed for automatic interlocking of manually-controlled circuits, or to permit manual operation of an automatically-operated system. In interlocked circuits, the valve can prevent out-of-sequence or accidental manual actuation, says manufacturer. In normally-automatic circuits, it permits manual operation for machine set-up, or emergency use. For interlocking, a stock diaphragm end section is fitted to a standard body, with a knob, lever or other type manual control mounted on the opposite end. Manual operation is unrestricted until air is applied to the diaphragm end. Actuation of the diaphragm returns the valve and holds it in status-quo position. Fitted with a return spring, the valve functions automatically, actuated by a three-way pilot valve, instrument or process control. With actuating pressure off, valve can be operated manually.

Auto-manual valves, for use in air, oil or vacuum service, are available with two-, three-, or four-way valve bodies. Piped or open end exhausts are optional on the latter two. Port sizes range from ¼ through 1 in. NPT. Valve bodies are Navy M bronze, stems are chrome-plated stainless steel, and diaphragms are of Neoprene-covered synthetic. Bulletin D-58 gives details. Valvair Corp.

22—COMPOUND inhibits corrosion in closed systems

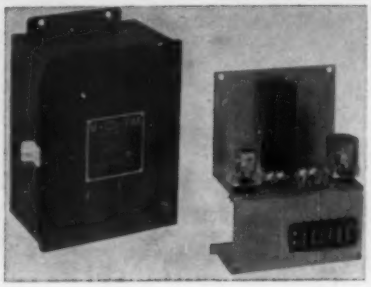
Unusual success in inhibiting corrosion in closed recirculating systems — with or without anti-freeze — is claimed for Corrosion Inhibitor CS, a non-chromate product. According to company, it protects not only steel, but also copper, brass, aluminum and solder. Field evaluation tests are reported to show it effective in preventing corrosion in air conditioning systems, diesel and gas engines, compressors, process cooling water systems, hot water boilers, heat pump systems etc. Corrosion Inhibitor CS is compatible with anti-freeze, it is stated; it won't stain or cause dermatitis, and requires a minimum of checking during standby because oxygen in-leakage doesn't affect its action. Hagan Chemicals & Controls, Inc.

23—BELT DRESSING in easy-to-use aerosol form

Sprazon can be sprayed on moving transmission belts. To apply this belt dressing, you hold the can 12 to 15 in. from the pulley and spray it on while the drive is running — rotation of the pulley transfers the film of sprazon to the inner surface of the belt. Graton & Knight Co.

24—METERING PUMPS for the controlled small flows

Designated CC Pumps, this line includes both plunger-type and diaphragm-type metering pumps. Both types operate on reciprocating action of a positive-displacement plunger; they differ in that the diaphragm pumps have a hydraulically-balanced teflon diaphragm between plunger and pumped liquid and are, therefore, suggested for more corrosive services. Unitized design of basic components permits conversion from one type to the other by simply substituting liquid-end assemblies. Straight-column, drop-out construction of liquid end results in improved flow characteristics and allows easy removal of valves for cleaning. Capacities range from one drop every 13 strokes to 1000 gph, at discharge pressures to 10,000 psi. The Clark-Cooper Co., Inc.



25—DELAY UNIT keeps gas valves open during voltage drops

M-Co-Pak Delay Units are designed to keep fuel shut off valves open for a 5-sec period in the event of power fluctuation or failure caused by thunderstorms, power changeover and the like. Three basic models are offered. Model A operates on 440-v, 220-v, or 110-v, 60-cycle current and is reported suited to most industrial gas furnace requirements. Model B incorporates an additional interlock for use with other types of safety devices. Model C is designed for use with flame safety controls and permits a greater variety of combinations for maintaining external circuits. The unit illustrated is shown with NEMA Type XII enclosure. Michigan Controls Co.

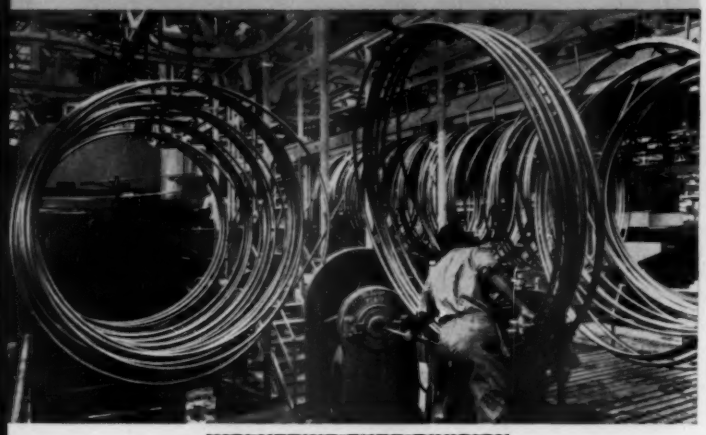
26—BIN LEVEL INDICATOR is sensitive, resists corrosion

Auto-Bin-Dicator is announced as a super-sensitive response mechanism effective for use with light materials without affecting its performance with heavy materials or for general purpose. Both standard and explosion-proof models of this automatic indicator are available. According to manufacturer, it differs from other units in company's line in that the entire body is heavy aluminum castings and the diaphragm stainless steel, making it corrosion resistant even when installed in a suspended central position in the bin.

The unit can be affixed to thick or thin walled bins, or suspended within the bin at any level through the use of a simple extension. It can also be used in chutes and hoppers to prevent overfeeding. In operation, pressure of ma-

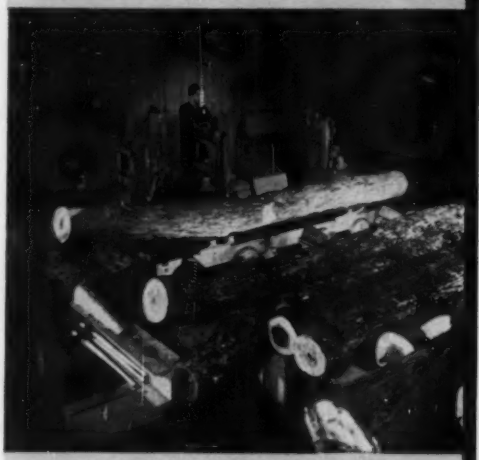
CALUMET DIVISION

LOOK TO CALUMET & HECLA...

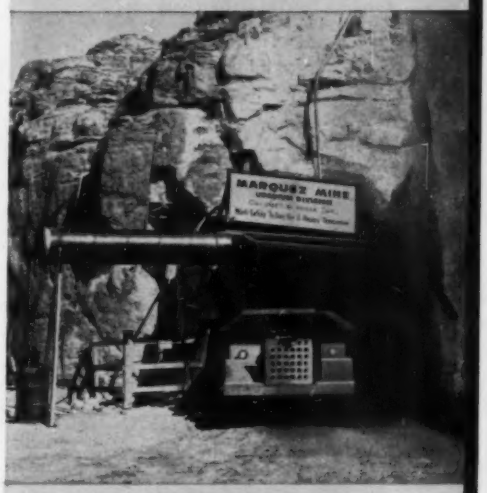


WOLVERINE TUBE DIVISION

LOOK TO WOLVERINE TUBE



GOODMAN LUMBER DIVISION



URANIUM DIVISION

Mining . . . refining . . . lumbering . . . agriculture . . . manufacturing — diversified indeed are the product and market areas of the companies making up the industrial family of Calumet & Hecla, Inc.

Of course, Calumet & Hecla has for many years been recognized as a copper producer. Since 1859, in Michigan's Upper Peninsula, the Calumet Division has been mining Lake copper — one of the purest forms of copper ore. The refined product is sent to Wolverine Tube Division for conversion into brass and copper tubing for plumbing installations, refrigeration, chemical and petroleum processing as well as for a wide variety of general industrial applications. Wolverine Tube is also a prime manufacturer of aluminum extrusions, and drawn and extruded aluminum tube.

The Calumet Division is widely recognized for the quality of the grinding balls and mill liners it manufactures for the mining industry, as well as for the agricultural oxides it produces for better farming.

From the trees in the vast forest areas of Calumet & Hecla holdings, Goodman Lumber Division manufactures plywood and other wooden products. C&H properties have turned up high grade uranium. The development of these properties and the extraction of this valuable element is the responsibility of the Uranium Division.

If any of the above products fall within the scope of your company's requirements, remember that you pick a winner every time you deal with a member of the Calumet & Hecla industrial family.

When you need tubing—LOOK TO WOLVERINE!!

CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
GOODMAN LUMBER DIVISION
WOLVERINE TUBE DIVISION

In Canada:
CALUMET & HECLA OF CANADA LIMITED
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO. LTD.
UNIFIN TUBE DIVISION

WOLVERINE TUBE
DIVISION OF
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Workmen lining boiler furnace enclosure with Laclede Super Plastic.

Which of these advantages does your present boiler lining lack?

Laclede plastic and castable refractory linings, properly selected and installed, give long service life, greater efficiency, and permit more flexibility than other types of refractory linings.

Specific advantages for boiler constructions include

- High thermal-shock resistance
- Long service life
- Minimum spalling
- Resistance to heavy loads, temperature variations, and the use of low-grade coal
- Especially suited to burner ports and flues
- Eliminate necessity for special tile around charging holes and access doors
- Air-tight settings, even in furnaces of irregular shape

Use **Laclede** plastic refractories for front and bridge walls, burner ports, suspended arches, ignition arch construction, as a backing for water walls, and in other areas where high heat resistance is necessary. For complete details, contact your Laclede representative. Or write to *Refractories Division, H. K. Porter Company, Inc., Porter Building, Pittsburgh 19, Pa.*

REFRACTORIES PORTER DIVISION

H. K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Copper and Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

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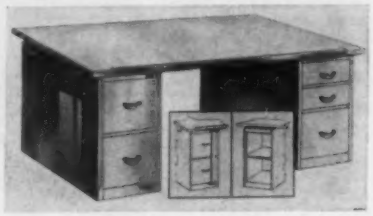
terial against the stainless steel diaphragm actuates a switch which operates signals, such as lights, bells or horns, and can be set to automatically start or stop the flow of material into or out of the bin and stop or start filling machinery. Bin-Dicator Co.

27—ENGINEERING DESK assembles, knocks down easily

The Assemblor is described as a flexible engineering desk which can be assembled or disassembled in a few minutes without tools. Offering both convertibility and ease of installation, the 31-in. high all-steel unit can be changed from a drafting table to an engineering or general office desk. Absence of protuber-

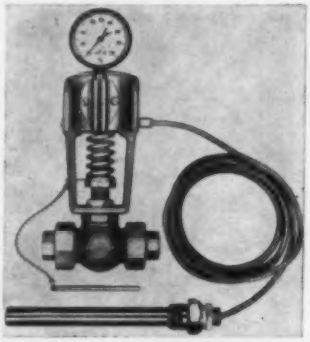


ances on component parts permits compact storage. When disassembled, the Assemblor consists of three separate parts with all cross member supports stored within the top.

The 31-in. height lets draftsmen sit in low posture-type chairs. Table top is 43½ by 72 in., and has an adjustment tilt bar which, when raised, gives a 6-deg inclination. Two file-drawer pedestals support the top and provide storage capacity. One pedestal has two utility drawers, a letter-size catalog drawer and a catalog and book compartment at the rear of the unit. The other pedestal has two full length drawers. Roll tracing holders on each side of the Assemblor permit work with drawings longer than 72 in. The unit is finished in gray and has a steel top covered with off-white linoleum. Professional Equipment Div., Hamilton Mfg. Co.

28—TEMPERATURE CONTROL has close corrective action

The self-operated American Temperature Regulator controls temperature through the throttling action of its valve on a steam or water line. It is designed



to respond instantly and powerfully to temperature change. Corrective stroke begins with less than 1/10 deg change in temperature at the bulb, says manufacturer; temperatures stay within the narrowest possible throttling band and

steam waste is eliminated. There is claimed to be virtually no maintenance or servicing necessary. The packless valve requires no lubrication, an internal safety spring protects against damage from accidental overheating; and stainless steel seats and discs are designed with disc guides outside the path of steam flow to eliminate wire drawing. Both an indicating model, with adjustable dial thermometer, and a non-indicating model come in sizes from ½ to 2 in. Ranges are from −15 to 50 F to 240 to 350 F. Bronze, stainless steel and plastic coated systems are available. Manning, Maxwell & Moore, Inc.

29—100-KVAR CAPACITOR offers installation economy

This 5-kv, three-phase, 100-kvar capacitor is claimed to improve power factor, relieve overhead transmission lines and improve voltage level. When compared with three single-phase capacitors, there are considerable savings in labor and material, it is pointed out, since one unit and one bracket are required for installation of the three-phase capacitor. More versatility in applying it to distribution lines is also announced. Since this capacitor can be supplied with single-crossarm, double-crossarm, or direct pole-mounting bracket, three-phase primary banks can be furnished with three-phase 4160-v units using simple-mounting supports. Westinghouse Electric Corp.

30—SUBMERSIBLE MOTOR for deep well turbine pumps,

This 4-in. submersible motor is designed to drive deep well turbine pumps in industrial and other water supply applications. Ratings offered in single phase construction are from 1½ to 5 hp, in three phase construction from 1½ to 7½ hp at 3550 rpm. According to company, greater horsepower capacity for its size is achieved by using an outside wound stator. This construction is claimed to permit more effective use of copper and iron for higher efficiency and torques. Motor stator is protected by a high dielectric insulation system, by encapsulation in a chemically inert plastisol and by sealing in stainless steel. Shaft height on motor can be adjusted to center pump impellers for pump efficiency. The Louis Allis Co.

31—PROPORTIONING PUMP for high pressure metering jobs

These high pressure, low capacity, variable volume, reciprocating plunger pumps are designed for feeding as little as 1.5 gph to as much as 108 gph of corrosive or non-corrosive liquids into chemical processes, food processes, water treatment systems and other applications where extreme accuracy and long pump life are requirements. Packaged chemical feed units incorporating these pumps with tanks ranging from 50 to 250 gal capacity are also available. Pumps are said to normally handle pressures to 625 psi and several thousand psi with special construction, and are available in 304 and 316 stainless,

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The only fuel that's sure to give you all 3!
CONSTANT SUPPLY
CONSTANT EFFICIENCY
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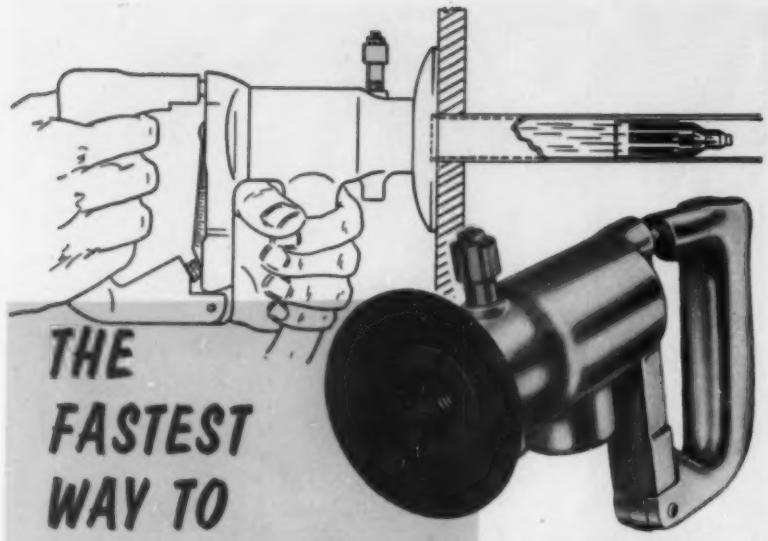

THE FASTEST WAY TO CLEAN CONDENSER TUBES

John Crane

Super-Jet

CONDENSER TUBE CLEANER

"John Crane" Super-Jet tube cleaning equipment offers the simplest yet most effective method for maintaining top heat transfer efficiency in steam condensers for these 5 reasons:

1. **EFFICIENT**—handy gun-and-slug method removes slime or scale in record time.
2. **VERSATILE**—interchangeable nozzles permit water or air operation. Slugs are available in types and sizes to insure positive cleaning under practically all conditions.
3. **SPEEDY**—one man can load an entire bank with cleaning slugs and shoot them through in rapid succession.
4. **ECONOMICAL**—slugs can be used over and over again. Rugged gun is built for long, hard service.
5. **EASY OPERATION**—simple-to-operate gun weighs only 2¾ lbs., does not require a skilled worker and can be used for lengthy periods without fatigue.

Request Bulletin P-324. Ask about special 10-day free trial offer.

Crane Packing Co., 6429 Oakton Street, Morton Grove, Illinois (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

Interchangeable Nozzles

Air or water operation—effective pressures 50-200 psi.

Slugs For All Services

Spool-type for normal slime removal, bullet-shaped for heavy or thick slime deposits and scraper-type for scale and mineral deposits. Latter two slugs have "jet action" holes that air or water-flush away deposits as removed.

John Crane

CRANE PACKING COMPANY

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Hastelloy, Carpenter 20 and other steels and ceramic plungers when corrosive liquids are to be metered. Walter H. Eagan Co., Inc.

32—VALVES feature color-coded adjusting scale

In Colorflow Valves, the adjusting scale is composed of easy-to-read color graduations. This is expected to simplify many basic control problems, and to enable even untrained personnel to check the valve setting at a glance, make quick adjustments, record the reading and reset the valve when necessary. The

color code consists of a number of permanently colored bands, each a different color. Each full turn of the screw exposes another color. In addition, the screw is graduated numerically so that the valve can set on red 5, blue 6 etc. Other new features incorporated in the Colorflow include a guided poppet stem to eliminate poppet "cocking" and assure accurate seating, and a needle stop to prevent the needle from being backed completely out, and a poppet stop to guard against spring damage. Flow control and needle valves in the Colorflow line come in five standard sizes from ⅛ to ¾ in. Standard models withstand up to 5000 psi. The Manatrol Corp.

33—CONNECTORS, for copper or aluminum, are easily installed

Color-keyed connectors, compatible with either copper or aluminum conductor, are installed with a new light-weight hydraulic tool which delivers 12-ton force. Tool installation range in the color-keyed series is from No. 12 aluminum or copper to 750 MCM aluminum or copper. Proper installation die is selected by matching its color with that on the connector to be installed. The die halves are then hand-inserted into the tool. The compression is completed

within seconds along the barrel of the connector to provide a permanent connection of high conductivity. The connector line includes terminals (one, two or four bolt holes) two-way connectors, taps (twin and parallel) and reducing connectors for reducing aluminum to copper of equivalent current carrying capacity. Thomas & Betts Co.

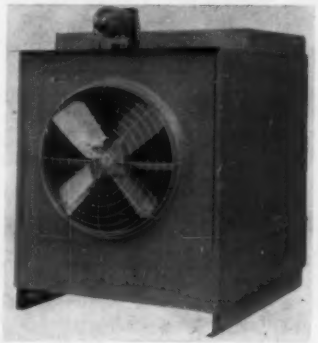
34—DISTRIBUTION SWITCHBOARDS, shallow in depth

Only 14-in. deep, these distribution switchboards are introduced for medium-size commercial and industrial buildings. They can utilize a variety of interchangeable distribution and control

units of modular construction, including circuit breakers, fusible switches, magnetic and manual motor starters and plug-in breakers. The new units are announced as featuring rigid construction and standardized parts and as offering flexibility, compactness and versatility. Three classes of incoming and distribution units are available: one containing a panelboard section; a second with a main disconnect section and space for utility metering; and a third with a panelboard section and space for utility metering. The switchboards are rated up to 600 v a-c and 250 v d-c. Their bus ratings are vertical, 200 to 1200 amp, and horizontal, up to 2000 amp. Federal Pacific Electric Co.

35—COOLING TOWERS offer more capacity in less space

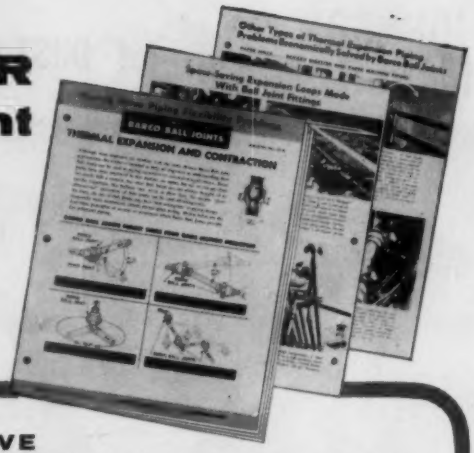
Series 3200 Hydra Glide Towers are packaged induced-draft water cooling towers for use with air conditioning



systems, as well as in plants where process water is required. The line is especially designed to provide more cooling capacity in less space — a unit

EVERY ENGINEER will want these FACTS!

NEW EDITION
Bulletin No. 31-A



"HOW TO SOLVE

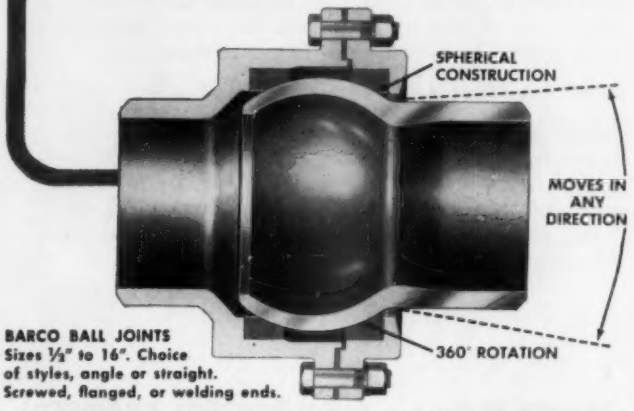
PIPE EXPANSION

PROBLEMS"

TODAY there is an easier way to accommodate *thermal expansion* in piping! No need to install special devices—in virtually every instance, you can put *flexibility* right in the line itself with standard BARCO BALL JOINTS:

1. **SUPERIOR METHOD.** New Steam Power Stations . . . Oil Refineries . . . Chemical Plants . . . Paper Mills . . . Office Buildings . . . Schools now are using this money-saving method.
2. **LONG LIFE.** No rubber, no thin metal members subject to fatigue or "blow-out." No lubrication, no grease packing. Self-adjusting; pressure sealing.
3. **FIRE-SAFE.** The joints have passed rigid fire, high temperature, and water quench tests.
4. **SAVE SPACE, CUT COSTS.** No pressure thrust — expensive anchoring or bracing not required to hold piping in place or in line. Cuts space required for pipe loops and U-bends.
5. **VERSATILE.** Easy to handle compound twisting movements, wide variations in temperature and pressure—steam, air, oil, water, gas and chemicals.

SEE your Barco Representative for information or write. Ask for the new revised Bulletin No. 31-A, "How to Solve Piping Flexibility Problems." *Engineering recommendations on request.*



BARCO BALL JOINTS
Sizes ½" to 16". Choice of styles, angle or straight. Screwed, flanged, or welding ends.

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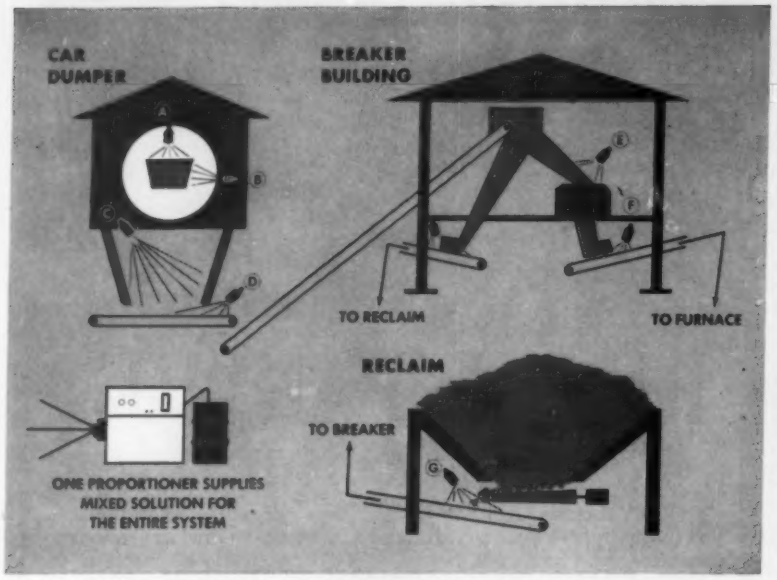
JOHNSON MARCH chem-jet DUST CONTROL SYSTEM



EFFICIENT DUST CONTROL IN COAL HANDLING GIVES 3 BIG COST SAVINGS... *plus protection against coal dust fire and explosion hazards*

Low First Cost:

You can buy a Chem-jet system at 1/10th the cost of dry collection systems. At the same time Chem-jet is guaranteed in most installations at least 90% efficiency.

Low Operating Cost:

Chem-jet operation costs only about 1/10th to 1/20th of a cent per ton of material treated.

Low Maintenance Cost:

Durable, foolproof Chem-jet systems need only a minimum of upkeep compared to other systems with hoods, ductwork, fans, larger motors, etc.

Dust Never Gets Airborne with Chem-jet

Chem-jet suppresses all types of air borne dust at its source by treating dusty materials with a Compound MR—a surface active agent . . . Investigate economical, flexible Chem-jet by writing today for latest bulletin. Johnson-March Corporation, 3018 Market Street, Philadelphia 4, Penna.

JOHNSON MARCH DUST CONTROL ENGINEERS

CANADIAN REPRESENTATIVES: G. F. STERNE and SONS ,LTD., BRANTFORD, ONTARIO

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of 7.5-ton capacity at 78 F wet bulb temperature is just 30 in. wide, 45 in. long and 54 in. high. The towers come in all-steel construction with plastic base coating or stainless steel. Heartgrade redwood filling, stainless steel fan shade and verturi-type fan throat are standard equipment. In capacities from 5 to 60 tons, these towers are assembled with slip-fit type joints to enable disassembly if required. Mason Products, Inc.

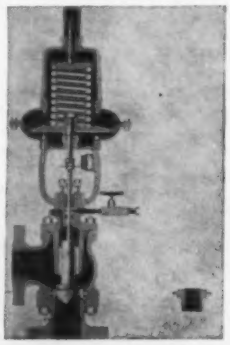
36—WIRING GUTTERS enclosed for weather protection

Designed primarily for outdoor installation, these raintight wiring gutters feature welded-on tops with deep overhanging flanges to prevent adverse elements from damaging the wiring. A

sealing device helps prevent tampering and the slip-on removable front covers require fewer screws for easier installation and maintenance. Gutters come in standard 4-by-4 in. and 6-by-6 in. sizes in 1-ft through 6-ft lengths. Formed of galvanized sheet steel, all are furnished with combination knockouts on bottoms. Keystone Mfg. Co.

37—CONTROL VALVE reduces turbulence and cavitation

This angle control valve features a venturi effect designed to reduce turbulence and cavitation in the control of slurries, viscous or flashing fluids. Pneumatically operated, valve has both a bolted tailpiece, permitting easy access to seat ring, and a bolted bonnet which permits



plug and stem replacement without removal of body. A broad range of applications are foreseen in petroleum refining, chemical manufacturing, paper-making, steam generation, and in the treatment of water, sewage and industrial waste. Valves are made of carbon steel and Type 316 stainless steel in sizes 1 through 6 in. with body ratings to 600 lb. They are available with full capacity or 40 per cent capacity trim. Minneapolis-Honeywell Regulator Co.

OXI CRYSTALS

"Open Sesame" to clean boilers and furnaces! ...more heat with less coal!

If you burn coal *OXI Crystals will increase boiler efficiency* by getting rid of slag, firescale, encrusted carbon and soot *fast* . . . all combustible deposits are completely oxidized from firedoor to the top of the stack . . . all this with very little labor involved.

By adding OXI Crystals you get more heat and steam with less coal. Superheater and economizer efficiencies increased. Stack temperatures are reduced. Cleaning costs are greatly reduced.

Ask for more information about this amazing product today.

Also ask about KOR, *the perfect fuel oil conditioner* . . . and SURFBLOW, *the floating, boiler water skimmer.*

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Better Pump Performance With SIMS PUMP VALVES

Because . . .

Stem breakage eliminated — by double shock-absorber stem heads.

Reduced wear — long guides give even lift — springs can't jam.

Smooth seating surface — rotating valve disc changes to new seating surface with every pump stroke.

Increased speed and pump capacity — inclined seat ribs cut flow resistance and reduces turbulence — prevents vapor binding.

Sims Pump Valves, for all reciprocating pumps, are stocked for quick delivery.

Write for Bulletin V-112.

Sims
PUMP VALVE CO., INC.
1314 PARK AVENUE, HOBOKEN, N. J.

SP111

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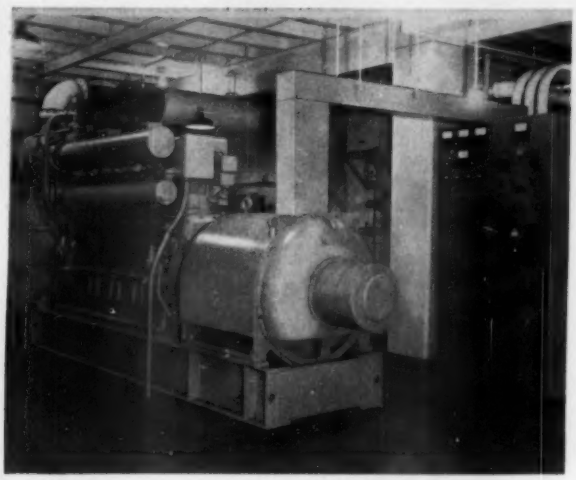
best reasons in the world why it's IDEAL*



Typical high speed unit with control.

*IDEAL high-speed generators and control equipment pictured above are typical of installations in hundreds of America's leading industrial plants, public utilities and commercial buildings. Custom-designed for longer life with proven efficiency and economy, IDEAL equipment is backed by over a half-century of creative electrical engineering and careful, conscientious workmanship. Unified responsibility for generating units and controls assures you of *better* products *better built* for dependable service with lower operating and maintenance costs. Why not check with IDEAL on your next power application problem?

Write for bulletin 505

The IDEAL ELECTRIC & MANUFACTURING CO.
303 East First St. Mansfield, Ohio

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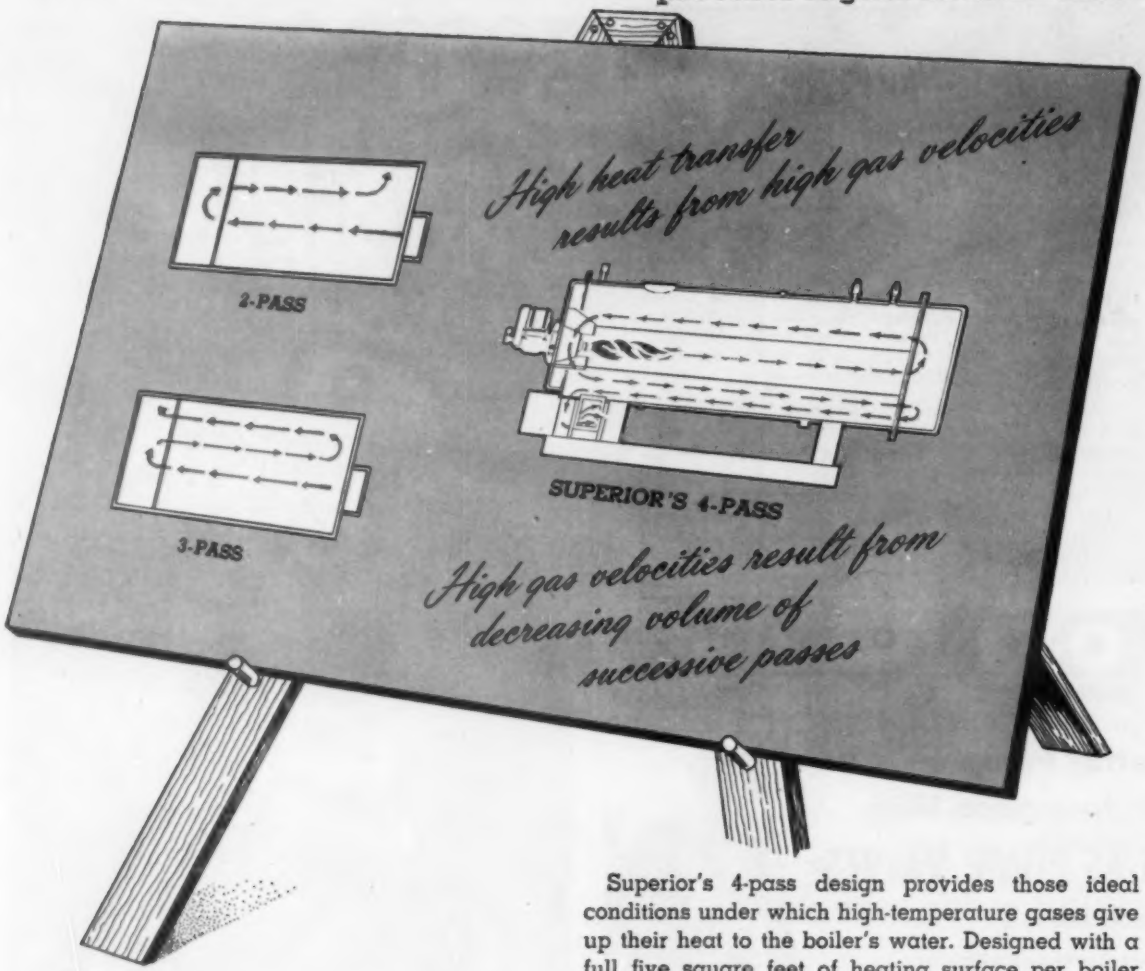
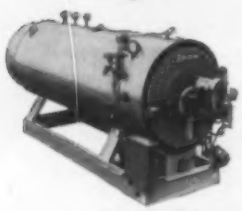
SUPERIOR'S 4-PASS DOWN DRAFT DESIGN

provides higher heat transfer


High heat transfer results from high gas velocities
2-PASS
SUPERIOR'S 4-PASS
3-PASS
High gas velocities result from decreasing volume of successive passes

Superior's 4-pass design provides those ideal conditions under which high-temperature gases give up their heat to the boiler's water. Designed with a full five square feet of heating surface per boiler horsepower, Superior boilers have reducing tube volume in successive passes. This reduced volume crowds the gases into intimate contact with the tube walls producing high velocities, and resulting in a continual scrubbing and cleaning action as the gases pass over the inner tube surfaces.

The down-draft arrangement of the 4-passes promotes the rapid steaming without surging, which results in dry steam . . . and in addition, this down-draft design traps the boiler heat during off periods, preventing its loss up the stack.



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Completely packaged fire-tube units for capacities from 20 to 350 bhp. Rotary burners on all sizes. Induced draft for clean, quiet safe operation. Fully insulated and ready for service burning oil, gas or both in combination. Pressures to 250 psi, or for hot water operation. Other fire-tube models for capacities to 600 bhp. Write today for Bulletin 12C.

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VALVES, TRAPS, AND PIPING

201 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. The Henry Pratt Co.

202 General Service Valves — Twenty-pp Bulletin E-165 is a guide to valves for general services. Types, typical applications, construction and operating features are discussed. Generously illustrated with drawings, photos and cutaways, booklet includes dimensional data. Everlasting Valve Co.

203 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations, describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Edward Valves, Inc.

204 Relief Valves — Eight-pp Bulletin 5200-A describes features of multiple disc relief valves for steam systems. Gives specifications for vertical, horizontal and angle Multiport relief valves in sizes from 4 to 28 in., 0–25 to 0–100 psig pressure. Provides installation diagrams, data on selection and specifying. Cochrane Corp.

205 Forged Steel Valves — Featured in comprehensive Catalog F-10 is detailed information and engineering data on company's line of forged steel valves, fittings, flanges and unions. Includes photos and cutaway views illustrating component features, as well as tables giving dimensional data. An engineering design section with complete specifications and pressure-temperature tables is included. Henry Vogt Machine Co.

206 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

208 For Lightest Condensate Loads — Bulletin T1744 (58) describes company's No. 30 impulse steam trap for use where condensate must be handled in very small amounts. Lists advantages and applications, tells how trap works and gives capacities, dimensions, materials used, prices. Yarnall-Waring Co.

209 Ball Float Traps — Eight-pp Bulletin 2891 describes a line of ball float traps for draining water from air, gas or steam lines, and for draining light liquid from gas under pressure. A section on how to select ball float traps is included. Armstrong Machine Works.

July, 1959

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1 2 3 4	101 102 103 104 105 106 107	201 202 203 204 205 206 207 208 209 210 211	501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521
5 6 7 8	108 109 110 111 112 113 114	212 213 214 215 216 217 218 219 220 221 222	522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542
9 10 11 12	115 116 117 118 119 120 121	223 224 225 226 227 228 229 230 231 232 233	543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563
13 14 15 16	122 123 124 125 126 127 128	234 235 236 237 238 239 240 241 242 243 244	564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584
17 18 19 20	129 130 131 132 133 134 135	245 246 247 248 249 250 251 252 253 254 255	585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605
21 22 23 24	136 137 138 139 140 141 142	256 257 258 259 260 261 262 263 264 265 266	
25 26 27 28	143 144 145 146 147 148 149	267 268 269 270 271 272 273 274 275 276 277	
29 30 31 32	150 151 152 153 154 155 156	278 279 280 281 282 283 284 285 286 287 288	
33 34 35 36	157 158 159 160 161 162 163	289 290 291 292 293 294 295 296 297 298 299	
37 38 39 40	164 165 166 167 168 169 170		
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Equipment						
1	2	3	4	101	102	103
5	6	7	8	108	109	110
9	10	11	12	115	116	117
13	14	15	16	122	123	124
17	18	19	20	129	130	131
21	22	23	24	136	137	138
25	26	27	28	143	144	145
29	30	31	32	150	151	152
33	34	35	36	157	158	159
37	38	39	40	164	165	166
41	42	43	44	171	172	173

104	105	106	107	201	202	203	204	205
111	112	113	114	208	209	210	211	212
118	119	120	121	215	216	217	218	219
125	126	127	128	222	223	224	225	226
132	133	134	135	229	230	231	232	233
139	140	141	142	236	237	238	239	240
146	147	148	149	243	244	245	246	247
153	154	155	156	250	251	252	253	254
160	161	162	163	257	258	259	260	261
167	168	169	170	264	265	266	267	268
174	175	176	177	271	272	273	274	275

Catalog Library

206	207	208	209	210	211	501	502	503
213	214	215	216	217	218	519	520	521
220	221	222	223	224	225	522	523	524
227	228	229	230	231	232	533	534	535
234	235	236	237	238	239	540	541	542
241	242	243	244	245	246	543	544	545
248	249	250	251	252	253	554	555	556
255	256	257	258	259	260	561	562	563
262	263	264	265	266	267	564	565	566
269	270	271	272	273	274	575	576	577
276	277	278	279	280	281	582	583	584
283	284	285	286	287	288	585	586	587
290	291	292	293	294	295	596	597	598
297	298	299				603	604	605

Advertised Products and Services

504	505	506	507	508	509	510	511	512
525	526	527	528	529	530	531	532	533
546	547	548	549	550	551	552	553	554
567	568	569	570	571	572	573	574	575
588	589	590	591	592	593	594	595	596

513	514	515	516	517	518	519	520	521
534	535	536	537	538	539	540	541	542
555	556	557	558	559	560	561	562	563
576	577	578	579	580	581	582	583	584
597	598	599	600	601	602	603	604	605

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210 Insulated Piping — Described in 20-pp Catalog 59-1 are prefabricated insulated piping systems for underground and overhead use. Cutaway views showing design and construction features are included, as well as dimensional diagrams and data, and photos of typical applications. Ric-wiL, Inc.

211 Rotary Joints — Described in Catalog 310 are rotary joints for use with steam, water, oil, air or gas, for temperatures to 450 F, working pressures 200 psi steam, 400 psi non-shock hydraulic. Illustrates design features, lists advantages, includes dimensional data. Also provides installation suggestions. Barco Mfg. Co.

Catalogs reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representatives.

212 Flexible Hose, Bellows — Sixteen-pp Catalog 187 describes applications and use of flexible metal hose and bellows. Engineering specifications and sizes, pressure ratings, materials and fitting attachments are included. Detailed drawings and pictures facilitate specifications of individual applications. Flexonics Corp.

PUMPS, COMPRESSORS

213 Controlled Volume Pumps — Bulletin 1257 described company's mini-Pumps for metering chemicals in minute volumes against pressures. Contains complete specifications on laboratory, industrial and chromatographic designs. Milton Roy Co.

214 Low Pressure Compressors — Eight-pp Bulletin A-95 describes a line of low pressure compressors for heavy duty industrial applications. Engineering design features are detailed and advantages explained. Joy Mfg. Co.

ELECTRICAL EQUIPMENT

215 Aluminum in Electrical Systems — Electrical applications of aluminum are described in this 32-pp bulletin. The report discusses current economics of choosing aluminum for a broad spectrum of electrical applications. Topics include conduit, wire and cable, bus conductor, busway, armored cables, enclosures and switchgear, lighting fixtures and accessories, and such components as reactors, transformers. Aluminum Co. of America.

216 Handbook on Fuses — This 12-pp booklet contains practical information on how to get safe, dependable, trouble-free electrical protection. Shows what to do when fuses blow, how to determine cause of blows, what kind of fuse to use for various circuits. Contains short history of fuses and notes on construction of fuses. Bussmann Mfg. Co.

BOILERS, GENERATORS

217 Fire Tube Boilers — This 12-pp catalog describes Superior Compact pack-

aged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features. Gives dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

218 Package Boilers — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators, and illustrates how installation of a package steam generator can raise steam capacity in an existing boiler room. Cyclotherm Div., National-U. S. Radiator Corp.

219 Hot Water Boilers — This 20-pp Brochure HCC-2 describes and illustrates design, construction, advantages and economics of the C-E La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process uses. Combustion Engineering, Inc.

220 Boilers for Many Services — This general product data catalog in loose-leaf notebook form contains detailed literature on company's line of boilers for heating, power and process steam. It contains separate data sheets for each product, including high pressure boilers, low pressure boilers, boiler-burner units, water-tube boilers, water heating equipment and others. In addition to photos and diagrams it provides tabulated engineering data. Industrial Div., American-Standard.

221 Packaged Steam Generator — Advantages of company's baffleless, pressurized two-drum water tube packaged units are detailed in 12-pp Catalog SB-59. Features of the completely integrated generating plant, which requires no field piping, wiring, brickwork or special foundation, are shown on cutaway illustration. Erie City Iron Works.

222 For Low-Pressure Heating — Guide Specifications GS-1, 59 pp, covers underfeed stoker applications to boilers best suited to commercial and industrial heating plants. Includes drawings of flexible layouts of the equipment, as well as specification criteria covering coal and ash handling, boilers, stokers and controls. Bituminous Coal Institute.

223 Integral-Furnace Unit — Bulletin G-94 describes the Type PFI integral-furnace boiler, a pressurized-furnace oil- and gas-fired steam generator for power, process or heating loads requiring steam capacities to 400,000 lb-hr. at pressures to 1150 psi and temperatures to 900 F. Includes information on membrane wall. The Babcock & Wilcox Co.

WATER CONDITIONING

224 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

225 Coagulant Aids — Featured in this product bulletin is a line of coagulant aids designed to improve floc formation in clarifying and softening water. Advantages are detailed and typical applications described. Calgon Co., Div., Hagan Chemicals & Controls, Inc.

226 Consulting Service — Advantages of company's consulting service are

Airetool tubular maintenance tools give work crews everything they need to clean boiler condenser and heat exchanger tubes faster, more efficiently. These tools are designed with plenty of power to get the job done right — in a hurry.

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detailed in 8-pp Bulletin 5006-A. How the service is qualified to solve problems concerning scale and corrosion control in boilers, cooling systems, and process waters is discussed. Dearborn Chemical Co.

227 Corrosion Control — Process Bulletin B6 describes company's condensate system corrosion inhibitors for protection of return lines, steam turbines, tanks and heaters. Discusses causes of condensate system corrosion and tells how inhibitors overcome these. National Aluminate Corp.

228 pH and Chlorine Control — The 14th, 1959 edition of company's handbook, "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium magnesium, silica, nitrate, hardness. Available to qualified power engineers, please state your job title. W. A. Taylor Co.

229 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117-A Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. Stickle Steam Specialties Co.

COAL AND ASH HANDLING

230 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

231 Hydraulic Shakeout — Bulletin 658 describes and illustrates the Carquake, hydraulically powered car shakeout designed for maximum car shaking with minimum noise. Rail- and stationary-mounted types are shown. Six advantages detailed. Stephens-Adamson Mfg. Co.

232 Coal Sample Crusher — How you can save on your fuel bill and power cost with company's coal sample crusher is explained in Bulletin CS2. Illustrated with photos and dimensional diagrams, discusses briefly the equipment's operation and features. Gruendler Crusher & Pulverizer Co.

TUBING AND ACCESSORIES

234 Heat Exchanger Tubing — Cited in 30-pp Catalog A-205 are typical cases where cupro-nickel on Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions required it. The International Nickel Co., Inc.

235 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers. Field of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

236 Tube Expanders — Bulletin Y-49 contains 12 pp of data on tube expanders designed to make a good hydraulic (or pneumatic) and mechanical seal between tube and tube sheet. Dimension and specification tables included. Elliott Co.

237 Electric Tube Cleaners — Bulletin E107 describes advantages and applications of company's electric tube cleaners for boilers, condensers, evaporators, and heat-exchangers. Tables are included giving complete specification details. Elliott Co. Roto Plant, Div. of Carrier Corp.

FUEL BURNING EQUIPMENT

240 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. The Engineer Co.

241 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses various components. Riley Stoker Corp.

242 Firing Units — Bulletin 28 describes steam atomizing packaged firing units for oil and/or gas fuels. Gives advantages of the units, specifications and general dimensions, and other data. National Airoil Burner Co., Inc.

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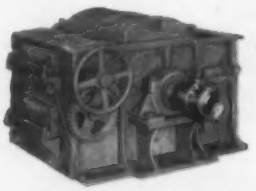

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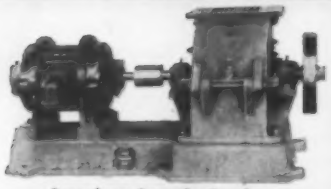

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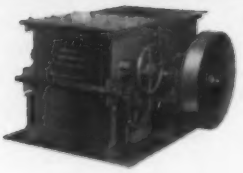

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243 **Spreader Stoker** — Catalog 860 contains 20 pp of detailed information on company's overthrow rotor type spreader stoker for boilers of medium size up to 60,000 lb steam per hr capacity. Describes features of design and operation and illustrates applications. Detroit Stoker Co.

INSTRUMENTS, CONTROLS

245 **Controls Data** — Comprehensive data on all types of controls, including diaphragm valves, pilot controllers, regulators, safety heads and tank vents are presented in this loose leaf notebook. Individual sections contain all pertinent information on each specific product, including descriptive details and engineering data, dimensions, specifications. Application and operation details are fully illustrated. Black, Sivalls & Bryson, Inc.

246 **Resistance Temperature Detectors** — In 8-pp Publication 3016D is described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operations, application and construction details of the resistance temperature detectors are presented. Instrument Div., Thomas A. Edison, Inc.

247 **Temperature Regulators** — Ten-page Bulletin 620-2 describes features and advantages of company's line of temperature regulators consisting of a thermostat with capillary tubing and a valve. Includes information on typical applications, as well as dimensional data, diagrams, valve selection chart. Sarco Co., Inc.

248 **Temperature Regulators** — Six-pp Bulletin 1012 describes company's line of steam regulating valves with pilots for both fast and slow heating exchangers. Selection tables and line drawings of typical applications are also included. Spence Engineering Co., Inc.

249 **Feedwater Control** — Bulletin 1013-D describes a feedwater control for modern high-duty steam generators. Operation of the control and its components are explained and its application with both standard size and miniature recorders shown. Copes-Vulcan Div., Blaw-Knox Co.

250 **Guide to Gages** — Catalog 300-B, 112 pp, features Ashcroft, Dura-gauges, Maxisafe, pneumatic receiver, recording, quality, drawn case, chemical and special application gages. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in. Manning, Maxwell & Moore, Inc.

251 **Metering, Control Systems** — Bulletin 500 describes purpose, design and operation of company's metering and control systems. Includes discussion and pneumatic and electric telemetering and pneumatic control, along with detailed literature references. Bailey Meter Co.

253 **Oil Leak Detection** — Eight-pp illustrated Bulletin 80, on the Paraprobe oil leak detection system for steam-type fuel oil heaters gives a detailed explanation of the operation of the system. Provides installation diagrams, standard specifications, explains determination of condensate flow rate. Davis Engineering Corp.

INSULATION

254 **Foam Insulation** — Expanded polystyrene insulation for cold storage ap-

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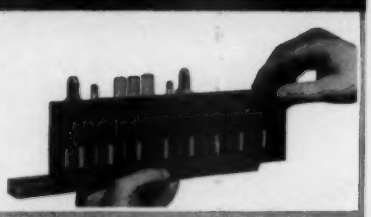

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plications is featured in this illustrated bulletin. Method of application is shown, and physical and thermal properties of the material listed. Johns-Manville.

255 Industrial Insulators — Thermal, mechanical, physical, and chemical characteristics of company's industrial insulations are presented in 20-pp Catalog J-424. Includes data on high temperature spun-mineral wool insulating block, blankets, pipe coverings and cements and on mineral wool industrial felts and duct insulation. Baldwin-Hill Co.

256 Mineral Insulation — Properties and characteristics of Gilsulate and its applications as a material for insulation and protection of underground hot pipes and systems are described in this illustrated booklet. Table of specifications is included. American Gilsonite Co.

AIR CONDITIONING AND DUST CONTROL

258 Precipitation Products — Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates installations. Western Precipitation Corp.

259 Dust Control Unit — Featured in Bulletin V-100 is a conditioner unit for dust control, designed to apply rapid, on-the-spot conditioning to dust materials in all types of handling. Principles of operation are described in an accompanying engineering data bulletin, Bulletin V-101. The Johnson-March Corp.

260 For Zone Control — Air conditioning zone control cabinets are described and illustrated in 20-pp Bulletin AC-220. Separate sections with tables, curves and sketches cover proper unit selection, physical data, dimensions, fan performance and coil ratings for water cooling, direct expansion, hot water and steam. Buffalo Forge Co.

OTHER EQUIPMENT

263 For Quiet Heating — Described in this bulletin is the HusHeater, designed to heat — without making a sound — water and liquids by introduction of steam into the liquid. Lists advantages of the HusHeater. Most common application is in filter boxes and hotwells. Sims Pump Valve Co. Inc.

264 Automatic Data Systems — Described in Bulletin MSP-154 are electronic data handling systems for logging, monitoring, and integration of process information. Discusses basic design parameters, programming, switching, analog to digital conversion, linearization, calibration, digital ranging, print-out and off-normal alarms, remote switching, digital variable indication, integration, computation. Hagan Chemicals & Controls, Inc.

265 Fuel Oil Additive — Described in this product sheet is an additive for boilers suffering from "tired" fuel oil. Advantages and characteristics are detailed. Kor Corp.

266 Story of Coal — This pocket-size booklet presents a complete picture of company's operations, traces the history of the coal industry and describes the many services and applications of coal. A colorful mural reproduced in the booklet pictures the part coal has played in civilization. Peabody Coal Co.

268 Mastic Cement — Bulletin 860 describes characteristics and advantages of a mastic cement designed for use in boilers, incinerators, and all types of industrial heating units. Technical and installation data. J. H. France Refractories Co.

270 Plumbing, Heating Supplies — Edition H is the current edition of this company's 126-pp general catalog on plumbing and heating repair parts, tools and accessories. Indexed and illustrated, the catalog gives information on uses. J. A. Sexauer Mfg. Co., Inc.

271 Laboratory Supplies — This 12 pp price list announces latest prices for a wide range of laboratory supply items, including water analysis sets, conductivity equipment, colorimetric comparators, glassware and supplies, chemical reagents, and company's photometer with replacement accessories. Betz Laboratories, Inc.

272 Instrument Tubing — Detailed information on various types of instrument tubing and accessories is presented in this 16-pp bulletin. Among tubing described is extruded polyethylene tubing, extruded nylon tubing, tubes of copper, aluminum, and/or steel with polyethylene sheath, tubing with vinyl sheath, bundled instrument tubing. Dekoron Products Div., Samuel Moore & Co.

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273 **Is Salt Just Salt?** — This is the title of an 8-pp bulletin describing salt characteristics and properties as well as geographical distribution. Variations in salt from different areas in the United States are illustrated and company's refined products described. Morton Salt Co.

274 **Pneumatic Tools** — Bulletin 68 gives features and specifications for pneumatic screwdrivers, nutsetters and accessories. All models are illustrated. Airetool Mfg. Co.

275 **Process Equipment** — Bulletin G-3B describes equipment for process industries, including pneumatic conveying systems, compressors and vacuum pumps, coolers and preheaters, blowers, gas and vacuum pumps, fans and gas washers, accessories. In addition to describing features and advantages of the equipment, it includes engineering data. Fuller Co.

276 **Mechanical Packings** — Service and technical details on chemically-inert Teflon packings are provided in 8-pp Bulletin P-325 covering company's Chemlon line. Presents 15 types of braided construction, rings, six types of molded construction, cup and cone rings, combination sets. Gives recommendations as to services, applications and temperatures, also information on pressures, dimensions, mechanical requirements. Crane Packing Co.

277 **Air Preheater** — Featured in this 14-pp booklet is a line of package air preheaters for small boilers and process applications. Fuel savings data is presented, as well as diagrams of typical arrangements, and other details of design and operation. The Air Preheater Corp.

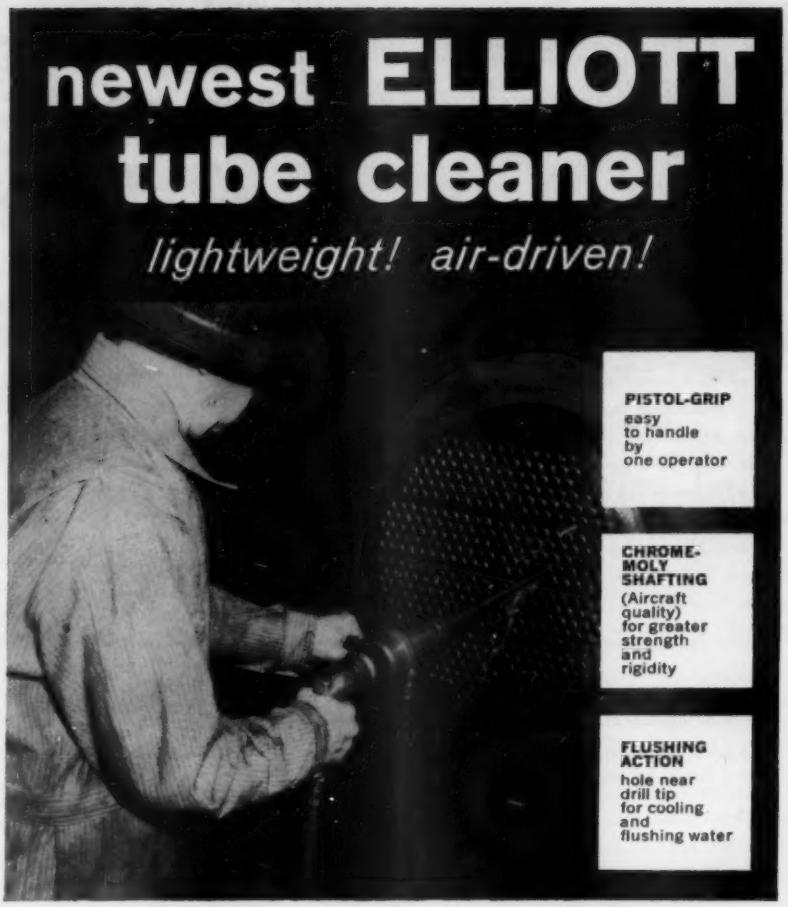
278 **Fire Resistant Fluids** — Characteristics and advantages of company's fire resistant hydraulic fluids are detailed in this product bulletin. Three types of fluid to suit specific requirements are described. Socony Mobil Oil Co., Inc.

279 **Worm Gear Reducers** — Complete horsepower and torque data for company's worm gear units built on 2½ up to 4-in. centers are given in full-page tables in Bulletin 5018. Dimensions are diagrammed and tabulated in detail, and materials and design of interchangeable components are described. De Laval Steam Turbine Co.

280 **Electric Heating Units** — Catalog 50, 50 pp, contains complete engineering data on electrical heating units and equipment, including strip elements, fin-strip elements, tubular elements, cartridge elements, ring elements, immersion heaters, circulation heaters, radiant heaters, forced air duct heaters, unit heaters, hot plates and others. Includes photos, dimensional drawings, prices, standard rating tables. Edwin L. Wiegand Co.

281 **Gas Turbine Engines** — A variety of applications for company's gas turbine engines are described in this 8-pp bulletin. Among the applications described are ground support for commercial jets, emergency shipboard use, power for offshore oil industry, and others. Solar Aircraft Co.

282 **Lance Type Blower** — Described in Bulletin 1079B are advantages and operation details of a short retracting lance type blower used for cleaning water-cooled furnace walls, hopper slopes or narrow portions of tube banks adjacent to walls. Sectional diagrams and photos are included. Diamond Power Specialty Corp.



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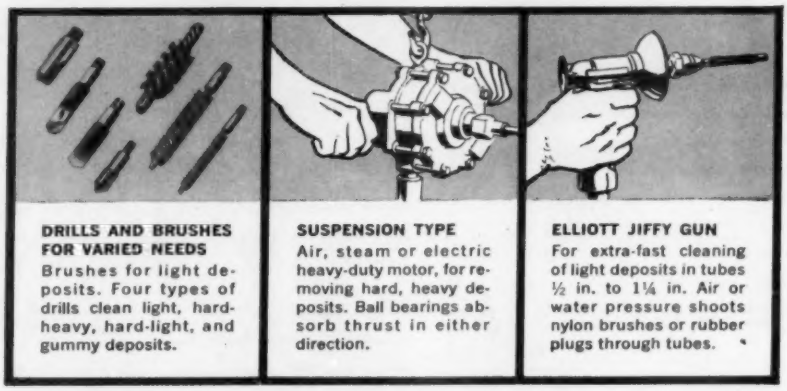

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Aerovent Fan Co., Inc. *
Air Preheater Corp., Inc. *
Airetool Mfg. Co., The 115
Aluminum Company of America 10-11
American Brass Co. 5
American Chain & Cable Co. Automotive & Aircraft Div. *
American Engineering Co. *
American Gilsonite Co. 35
American Hard Rubber Company *
American Pulverizer Co. 116
American-Standard Industrial Division 38-39
Ames Iron Works *
Armstrong Machine Works 7
Atomics International 42
Automotive & Aircraft Div. American Chain & Cable Co. *

Babbitt Steam Specialty Co. *
Babcock & Wilcox Co., The Boiler Div. Cover II-1
Babcock & Wilcox Co., The Refractories Div. *
Bailey Meter Company 29
Baldwin-Hill Co. *
Baltimore & Ohio RR 107
Barco Manufacturing Co. 109
Barsad Additives 121
Betz Laboratories, Inc. 36-37
Biddle Co., James G. *
Bigelow Company, The *
Bird-Archer Co., The *
Bituminous Coal Institute *
Black, Sivalls & Bryson, Inc. 103
Buffalo Forge Company 47
Bussmann Mfg. Co. *

Calgon Co. 22
Cambridge Instrument Co., Inc. *
Cleaver-Brooks Co. *
Cochrane Corporation *
Combustion Engineering, Inc. 12-13
Copes-Vulcan Div., Blaw-Knox Co. 26
Crane Co. 101
Crane Packing Co. 108
Cyclotherm Div. National-U.S. Radiator Corp. *

Davis Engineering Corp. 54
Dearborn Chemical Co. Cover III
De Laval Steam Turbine Co. 40-41
Detroit Stoker Company 99
Diamond Power Specialty Corp. *

Eastern Gas & Fuel Associates *
Edison, Thomas A. 97
Edward Valves, Inc. 48-49
Elliott Co. 119
Ellison Draft Gage Co. *
Engineer Co., The *
Erie City Iron Works 16-17
Everlasting Valve Co. *

Fairmount Chemical Co., Inc. 116
Fisher Governor Co. *
Flexonics Corp. *
Foster Wheeler Corp. 20-21
Fuller Co. 19

General Coal Co. *
Globe Co., Products Div. *
Goodall Rubber Co. 32
Graver Water Conditioning *
Gruendler Crusher & Pulverizer Co. 121

Hagan Chemicals & Controls, Inc. 50
Hall Laboratories *
Harco Corporation, The *
Heyl & Patterson, Inc. *
Hills-McCanna Co. *

Ideal Electric & Mfg. Co. 111
Illinois Water Treatment Co. *
Industrial Instruments, Inc. *
International Nickel Co., The *

Johns-Manville *
Johnson-March Corp. 110
Joy Mfg. Co. 51

E. Keeler Co. *
Kirk & Blum Mfg. Co. *
Koppers Co., Inc. 55

Lacledo Stoker Co. 118
Leffel & Co., The James *
Leslie Co. *

Madden Corp. 118
Manning, Maxwell & Moore, Inc. *
Marley Co., The *
Mead-Morrison Division, McKiernan-Terry Corp. 33
Milton Roy Co. 31
Moore & Co., Samuel 30
Morton Salt Co. 93
Murray Iron Works Company *

Nagle Pumps, Inc. *
National Airoil Burner Co., Inc. 121
Nalco Chemical Co. *
Neff & Fry Co. *
Niagara Blower Company *

Ohio Carbon Company 122
OXI Corp. 111

Peabody Coal Co. 15
Pfizer & Co., Chas. 90-91
Pickands Mather & Company *
Pittsburgh Piping & Equipment Co. *
Porter Co., Inc., H. K. Refractories Div. Lacledo Christy Works 106
Powell Valves, Wm. 53
Pratt Co., Henry *

Raybestos-Manhattan, Inc. *
Reliance Gauge Column Company *
Republic Flow Meters Co. *
Research-Cottrell, Inc. *
Revere-Copper & Brass Inc. *
Ric-wil, Inc. 23
Riley Stoker Corporation 24-25
Roto Div. of Elliott Co. 34

Sarco Company, Inc. *
Setlow & Son Inc., M. 121
Sims Pump Valve Co. 111
Solar Aircraft Co. 18
Spence Engineering Co. 14
Standard Oil Co. (Indiana) *
Stephens-Adamson Mfg. Co. *
Stickle Steam Specialties Co. 117
Stone & Webster Engineering Co. *
Superior Combustion Industries, Inc. 112

Taylor & Co., W. A. 117
The Terry Steam Turbine Co. 2
Texaco, Inc. *

Union Asbestos & Rubber Co. *
Union Iron Works *
U. S. Electrical Motors *
Universal Atlas Cement Co. *

Valley Camp Coal Co., The *
Vogt Machine Co., Henry 95

Webster Mfg. Co. *
Western Chemical Company *
Western Precipitation Corp. *
Wickes Boiler Co. *
Williams Gauge Co. *
Wilson, Inc., Thomas C. 122
Wolverine Tube Div. 105
Worthington Corporation Back Cover
Wright-Austin Co. *

Yarnell-Waring Company 8-9, 56
Yuba Consolidated Industries, Inc. *

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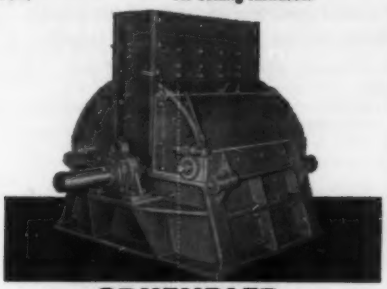

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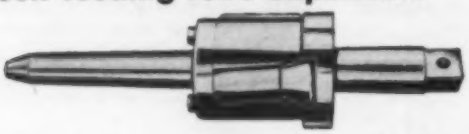

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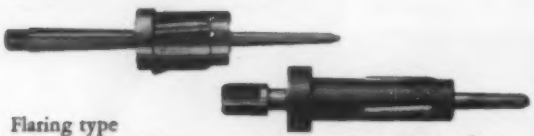

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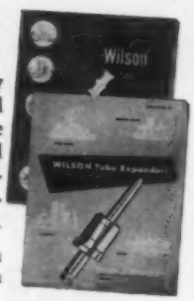

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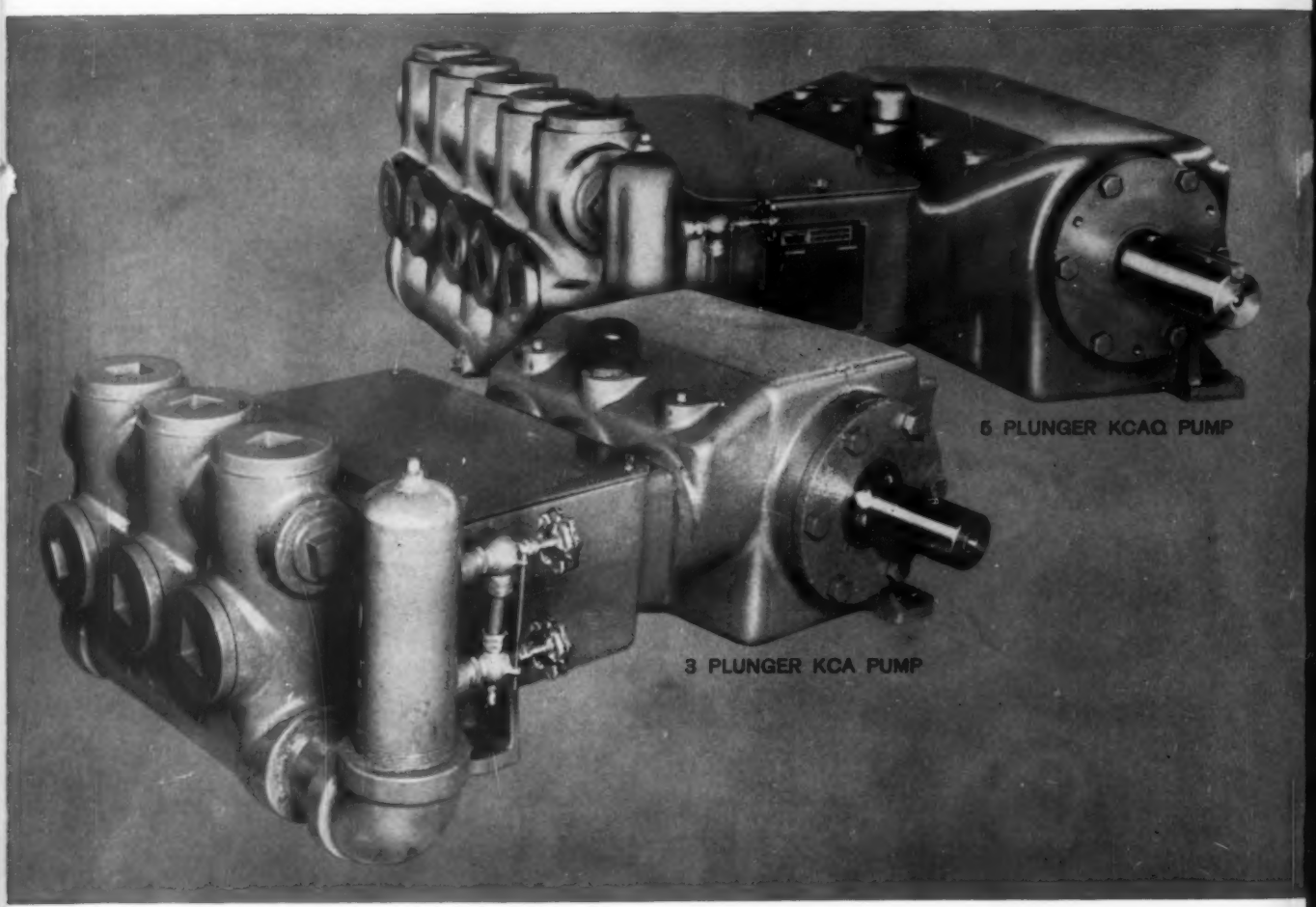

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